# Engine Workshop Manual

# Rolls-Royce Silver Cloud II and Bentley S2

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# Preface

This Workshop Manual has been compiled in an endeavour to assist service personnel responsible for maintenance and overhaul, in properly maintaining the high standard of engineering achieved in the production of the Rolls-Royce Silver Cloud II and Bentley S.2 cars.

The book is copiously illustrated with photographs and orthographic reproductions which are suitably annotated in order to provide quick reference with minimum searching.

Although all information contained in the Manual was correct when going to print, modifications which may subsequently develop will be kept up to date by means of Service Bulletins.

Information given in the latest Bulletin will supersede that given in the Section of the Manual to which it refers, until such time as the Manual is re-issued with the necessary amendments.

Personnel of Rolls-Royce Service Departments at Hythe Road, Willesden, London, N.W.10, and at Pym's Lane, Crewe, are always prepared to answer queries or give advice on individual servicing problems, but it will assist them if queries are accompanied by the chassis number of the car.

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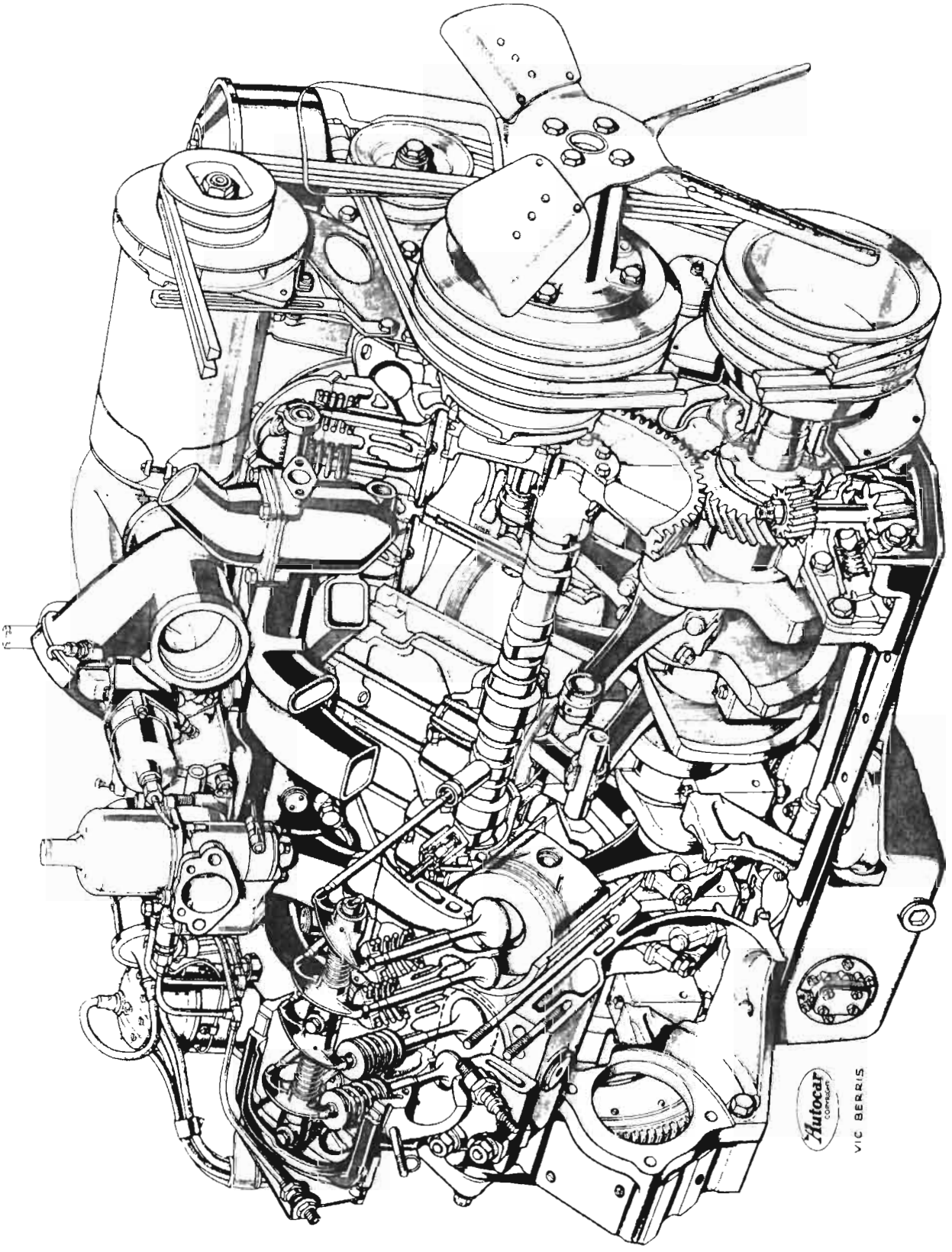


Fig. E1 Cut-away view of engine

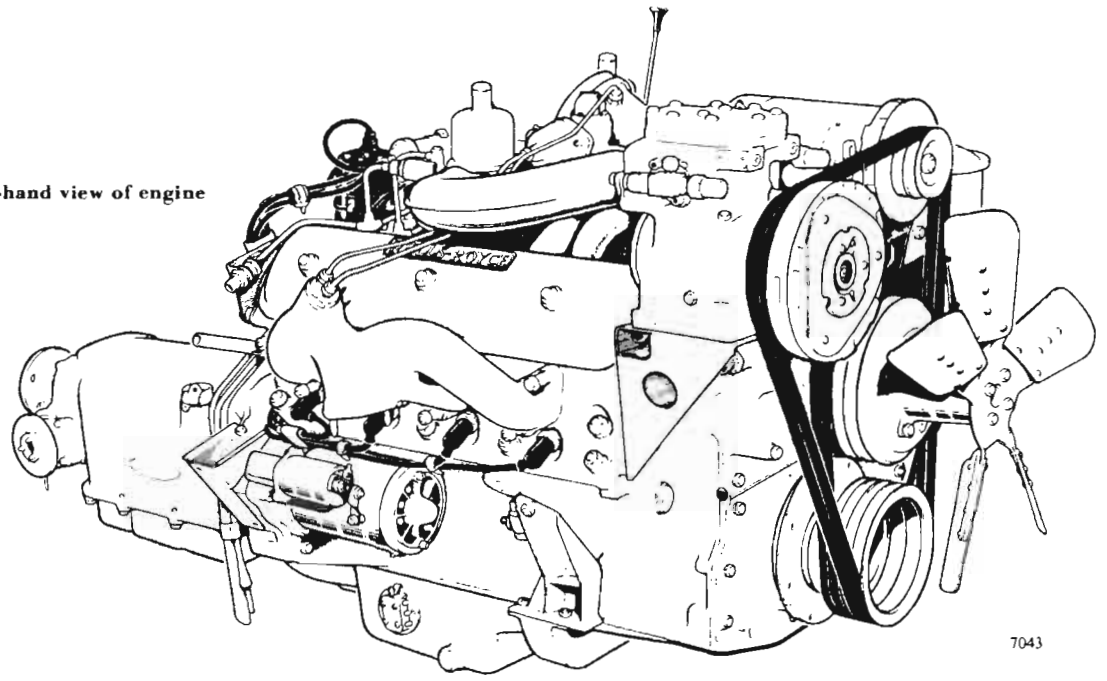


**Fig. E2 Right-hand view of engine**

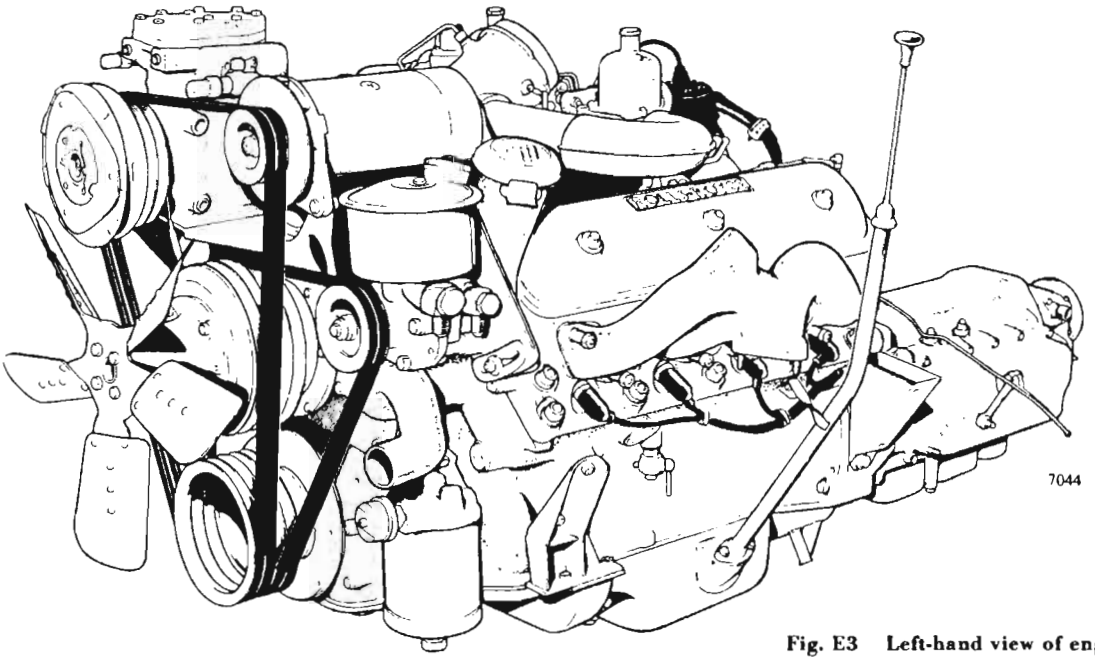


**Fig. E3 Left-hand view of engine**

## Section E1

## GENERAL INFORMATION

**Identification of the two banks of the engine**

Throughout this Manual, continual references are made to 'A' bank and 'B' bank cylinder heads, pistons, etc. This system has been devised for easy identification of the two banks of the engine and is recognisable by the following.

When viewing the engine from the driver's seat, the left-hand bank is 'B' bank and the right-hand bank is 'A' bank.

**Helicoil screw thread inserts**

On the Rolls-Royce power unit Helicoils have been fitted where, because of servicing necessities, parts may have to be removed and refitted at regular intervals. They have only been used where the parts are secured by setscrews and not where studs are fitted.

Helicoil screw thread inserts are made of precision formed stainless steel wire of diamond section and when fitted in specially tapped holes they provide threads of the conventional dimensions with a higher loading strength and offer a far greater resistance to wear, stripping, seizing and corrosion of the threads.

New Helicoils can be fitted quite simply by means of the insertion tool shown in Figure E4, adopting the following procedure.

Withdraw the mandrel and driving handle from the threaded nozzle and loading chamber. Place the insert in the chamber with the tang end lying towards the nozzle. Slide the slotted mandrel through the insert and engage the tang in the slot. Turn the mandrel and handle in a clockwise direction, applying gentle pressure on the insert until it is threaded into the nozzle. Continue turning until the first coil of the insert just emerges from the nozzle.

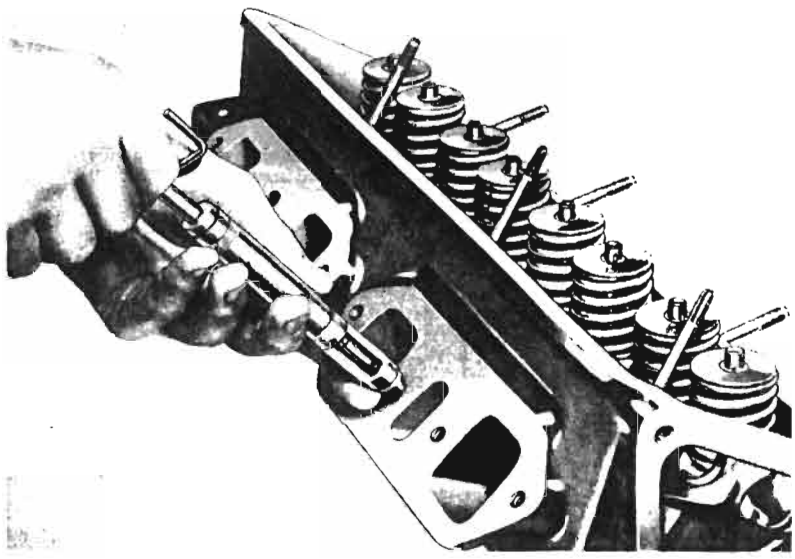

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**Fig. E4 Helicoil insertion tool**

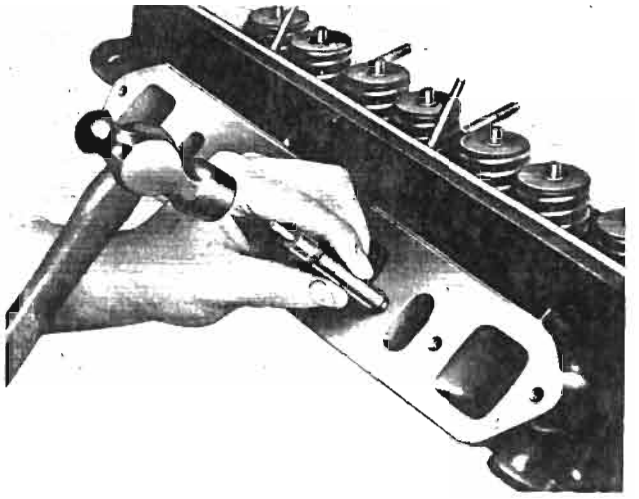

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**Fig. E5 Helicoil tang break-off tool**

Place the insertion tool over the tapped hole, ensuring that it is square to the work face. Recommence winding until the insert is transferred from the nozzle to the tapped hole. At this stage it is essential that pressure is not applied.

When the Helicoil is finally fitted the last coil should be from $\frac{1}{4}$ to $\frac{1}{2}$ a pitch below the surface of the work face.

Certain holes are 'through holes' and in this case it is necessary to remove the tang. Before fitting Helicoil inserts to 'through holes' it should be ascertained that the insert tang is notched for easy break-off. Inserts that do not have notched tangs should only be fitted to 'blind holes'.

To remove the tang from the insert use the break-off tool specially provided for the purpose (see Fig. E5). Insert the punch into the Helicoil and deliver a sharp hammer blow to the end of the sliding piece of the punch. The tang will break off quite cleanly at the notch. *Ensure that the tang does not fall off into the engine crankcase, etc.*

If for any reason it is necessary to remove a Helicoil, the following procedure is recommended, using the Helicoil extraction tool (see Fig. E6).

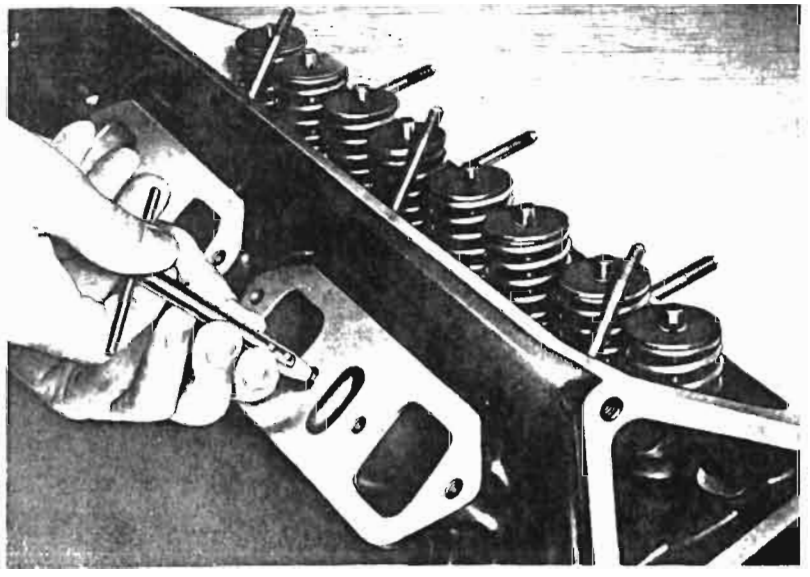

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**Fig. E6 Helicoil extraction tool**

Insert the blade of the extraction tool into the top coil of the thread insert. Press downwards on the insert and at the same time turn the blade in an anti-clockwise direction. The insert will wind out of the hole quite easily.

**Unified screw threads**

The need for a common standard of screw threads in the United Kingdom, Canada and the United States of America, has led to an agreement between the countries concerned to use UNIFIED THREADS of a mutually acceptable form, pitch and diameter.

There are three types of unified thread:

1. Unified Coarse — UNC.
2. Unified Fine — UNF.
3. Unified Special — UNS.

These Unified Threads are clearly identified by the standard system of markings, as illustrated in Figure E7.

There is little difference between the form of the American National Thread and the Unified Thread; therefore the new threads are largely interchangeable with S.A.E. standards. They are not, however, interchangeable with B.S.F., and although B.S.W. have the same number of threads per inch as the Unified Coarse Series, interchanging is not recommended due to a difference in the thread form.

The following types of thread are used on nuts, bolts and castings fitted to Rolls-Royce and Bentley cars.

For all sizes below $\frac{1}{4}$ in. diameter, B.A. threads are used.

For all sizes between $\frac{1}{4}$ in. and $\frac{3}{4}$ in. diameter inclusive, the Unified Fine thread is used.

All sizes above $\frac{3}{4}$ in. diameter have been classified by Rolls-Royce and Bentley Motors as Unified Special and have 16 threads per inch.

The Unified Coarse Thread is not used.

Where nut, bolt and setscrew sizes occur in the text of this Manual, the sizes are given by the 'across the flats' (A/F) measurements to assist spanner selection.

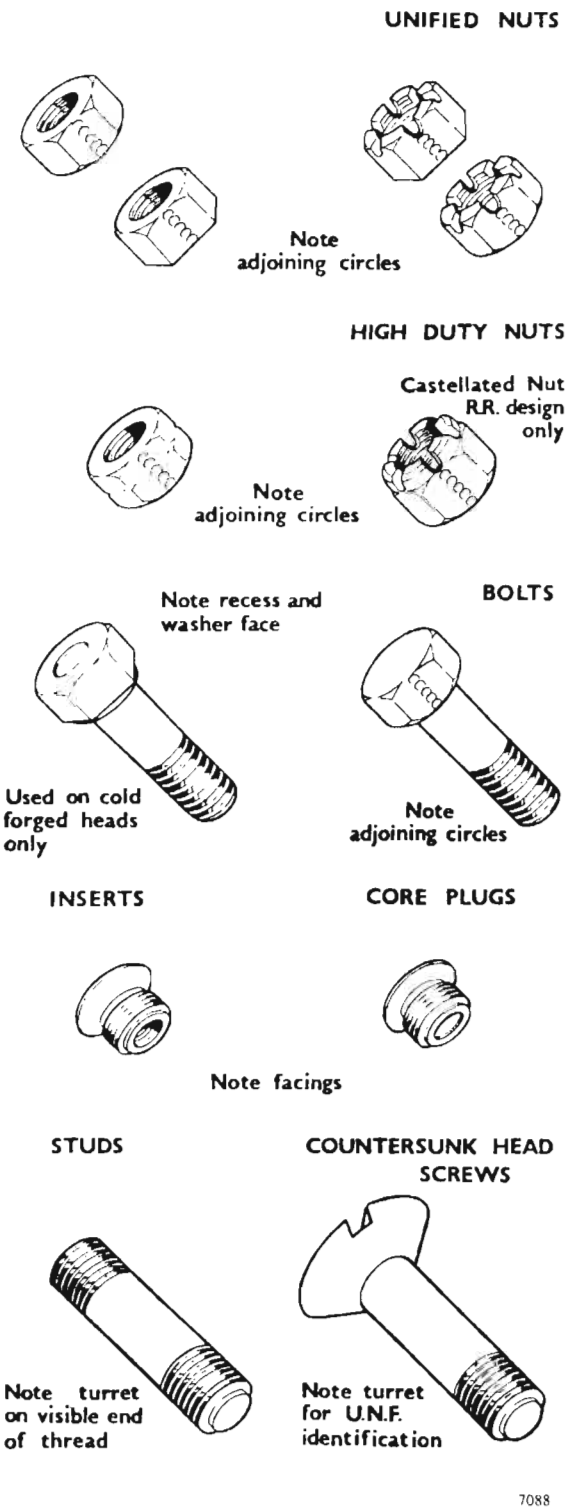



Fig. E7 Identification of unified threads

# Section E2

# ENGINE DATA

## SPECIFICATION

| | |
|---|---|
| Type | Over square 90° V formation, liquid cooled |
| Number of Cylinders | Eight—in two banks of four |
| Bore | 4.100 in. |
| Stroke | 3.600 in. |
| Cubic capacity | 380.2 cu. in. (6230 c.c.) |
| R.A.C. rated H.P. | 53.8 |
| Compression Ratio | 8:1 |
| Suspension | The engine and gearbox are of unit construction. The unit is flexibly mounted on rubber at three points. Single-point at the front and two-point at the rear |

## CYLINDER BLOCK

| | |
|---|---|
| Type | Monobloc casting |
| Material | Cast aluminium alloy |

## CYLINDER LINERS

| | |
|---|---|
| Type | Detachable wet liners |
| Material | Centrifugally spun cast iron |

## CYLINDER HEADS

| | |
|---|---|
| Description | Two detachable heads, each having four separate inlet and exhaust ports |
| Material | Aluminium alloy, with phosphor-bronze exhaust valve guides and cast iron inlet valve guides and with exhaust and inlet valve seat inserts of austenitic steel |

## CRANKSHAFT

| | |
|---|---|
| Description | Five-journal crankshaft with four crankpins. Integral balance weights and dynamically balanced |
| Material | Chrome molybdenum steel |
| Damper | Metalastik rubber vibration damper |
| Direction of rotation | Clockwise |

## MAIN BEARINGS

| | |
|---|---|
| Type | Split thin shells with 'pre-sized' bores to suit crankshaft journal diameters |
| Material | Steel backed copper-lead with either lead-tin or lead-indium overlay |
| Number | Five |

## CONNECTING RODS

| | |
|---|---|
| Type | 'H' section. Forged to size and balanced |
| Material | Chrome molybdenum steel |
| Big-end bearings | Copper-lead with either lead-tin or lead-indium overlay thin steel shells with 'pre-sized' bores to suit diameter of crankpins |
| Gudgeon pin bushes | Pressed into connecting rod small-end bosses |
| Material | Lead-bonze, steel backed |

## PISTONS

| | |
|---|---|
| Type | Full skirt, with recessed crown |
| Material | Aluminium alloy |
| Number of rings | Four. Three compression rings and one oil control ring. Top compression ring is chromium plated. Bottom two have tapered edges |

## CAMSHAFT

| | |
|---|---|
| Material | Cast Monikrom iron |
| Cams | 5′— 7′ longitudinal taper |
| Number of journals | Four |
| Bearings | Four babbit lined steel shells |
| Thrust taken | On front end |
| Drive | Through helical tooth gears |

## VALVE GEAR

| | |
|---|---|
| Inlet valves | Overhead push rod operated. Single spring. Steel collets with rubber tips to control valve stem lubrication. 45° seat angle |
| Material | EN.24 or S.65 |
| Exhaust valves | Overhead push rod operated. Single spring. Steel collets with rubber seals to control valve stem lubrication. Seat angle 45° |
| Material | KE.965. Stellite tips and valve seats. Brightray coated head |
| Valve timing | 5° A.T.D.C. |
| Tappets | Self-adjusting hydraulic tappets with spherical base |
| Material | Hardenable cast iron |
| Push rods | Ball-ended tubes |

## LUBRICATION SYSTEM

| | |
|---|---|
| General<br>For chassis and engine numbers see Service Bulletin S2/E1 | High pressure oil feed to crankshaft, connecting rods and No. 1 and 4 camshaft bearings and tappets, push rods and rocker ball-end seatings. Intermittent oil feed through camshaft to rocker shaft, rocker arms, valve tips, remaining camshaft bearings and camshaft timing gear. Splash feed to connecting rod small-ends, gudgeon pins and cylinder walls |
| General<br>For chassis and engine numbers see Service Bulletin S2/E1 | High pressure oil feed to crankshaft, connecting rods, camshaft bearings and tappets, push rods and rocker ball-end seatings. Intermittent oil feed through camshaft to rocker shaft, rocker arms, valve tips and camshaft timing gears. Splash feed to connecting rod small-ends, gudgeon pins and cylinder walls |
| Type | Pressurised, wet sump system |
| High pressure supply | 1000 r.p.m., 37 lb./sq. in. approx. |
| Relief valve | 40 lb./sq. in. |
| Sump capacity | Minimum — 6 pts. (Imp.), 7.2 pts. (U.S.), 3.4 litres<br>Maximum — 12 pts. (Imp.), 14.4 pts. (U.S.), 6.82 litres |
| Oil pump | Spur gear type with fine mesh strainer pick-up |
| Oil filter | 'British' Full Flow type with built-in relief valve |

## FUEL SYSTEM

| | |
|---|---|
| Carburetters | Two S.U. H.D.6 diaphragm type. 1.750 in. choke bores. Automatic choke for cold starting |
| Air cleaner | Dry, paper type, Purolator element MF.192 |

## COOLING SYSTEM

| | |
|---|---|
| Capacity | 21 pts. (Imp.), 25.21 pts. (U.S.), 11.93 litres |
| Pump | Centrifugal |
| Fan | 5-blade |
| Fan Diameter | 18 in. |
| Pump and fan drive | 13/32 in. adjustable 'V' belts |
| Radiator matrix | Film type |
| Coolant temperature control | 75°C. — 78°C. |
| Coolant | An inhibited solution of ethylene glycol to Specification DTD.779 |

## EXHAUST SYSTEM

Straight through large diameter pipe with two acoustic resonators and one absorption damper in series

## IGNITION DISTRIBUTOR

| | |
|---|---|
| Make and type | Delco Remy. Twin contact breaker with synchronized contact breaker arms |
| Rotation | Anti-clockwise |
| Advance mechanism | Automatic with centrifugal governor |
| Ignition timing | 2° B.T.D.C. |
| Firing order | A1, B1, A4, B4, B2, A3, B3, A2 (1, 5, 4, 8, 6, 3, 7, 2) |
| Contact gap | 0.019 in. — 0.021 in. |
| Drive | Through camshaft skew gears |

## IGNITION COIL

| | |
|---|---|
| Make | Lucas or Delco Remy |

## SPARKING PLUGS

| | |
|---|---|
| Make and type | Lodge C.L.N.P. or Champion R.N.8 |
| Gap | 0.024 in. — 0.027 in. |

# Section E3

# ENGINE DIMENSIONAL DATA

| DESCRIPTION | DIMENSION | PERMISSIBLE WORN DIMENSION | REMARKS |
|---|---|---|---|
| **CRANKCASE AND CYLINDERS** | | | |
| Cylinder liner bore grading | H. 4.100 in. — 4.1003 in.<br>J 4.1004 in. — 4.1007 in.<br>K. 4.1008 in. — 4.1011 in.<br>L. 4.1012 in. — 4.1015 in.<br>M. 4.1016 in. — 4.1019 in. | 0.004 in. Wear<br>0.003 in. Ovality | If these measurements are exceeded a new assembly of liner and piston must be fitted |
| Cylinder liner 'nip' | 0.002 in. — 0.003 in. | — | New liners must be selectively fitted or ground on the end to give this dimension |
| **PISTONS** | | | |
| Piston grading | H. 4.0985 in. — 4.0988 in.<br>J. 4.0989 in. — 4.0992 in.<br>K. 4.0993 in. — 4.0996 in.<br>L. 4.0997 in. — 4.1000 in.<br>M. 4.1001 in. — 4.1004 in. | — | Piston clearance in the bore 0.0012 in. — 0.0018 in. measured 0.906 in. from the bottom of the skirt across the thrust axis |
| Compression ring groove widths | 0.0807 in. — 0.0817 in. | — | — |
| Compression ring widths | 0.0777 in. — 0.0787 in. | — | The rings should be assembled with staggered gaps |
| Clearance | 0.002 in. — 0.004 in. | 0.005 in. | |
| Compression ring closed gap | 0.015 in. — 0.020 in. | 0.025 in. | |
| Open gap, nominal | 0.520 in. | — | — |
| Scraper ring groove width | 0.178 in. — 0.179 in. | 0.181 in. | |
| Scraper ring width | 0.1755 in. — 0.1760 in. | | Neglecting spring |
| Clearance | Nil | | Clearance taken up by spring load |
| Closed gap | 0.015 in. — 0.020 in. | 0.025 in. | — |
| Open gap, nominal | 0.520 in. | — | — |
| **GUDGEON PINS** | | | |
| Bore diameter in piston boss | 0.8749 in. — 0.8751 in. | — | — |
| Gudgeon pin diameter | 0.8751 in. — 0.8753 in. | — | — |
| Interference in boss | 0.0002 in. | | By selective assembly — at room temp. 68-72°F. |

| DESCRIPTION | DIMENSION | PERMISSIBLE WORN DIMENSION | REMARKS |
|---|---|---|---|
| **CRANKSHAFT AND CONNECTING RODS** | | | |
| Connecting rod small-end bush, internal diameter | 0.8753 in. — 0.8755 in. | — | — |
| Clearance on gudgeon pin | 0.0000 in. — 0.0004 in. | 0.0005 in. | At room temp. 68-72° F. |
| Big-end bearing housing, internal diameter | 2.3950 in. — 2.3955 in. | — | — |
| Big-end bearing shell, internal diameter | 2.2505 in. — 2.2515 in. | — | — |
| Crankpin diameter | 2.2485 in. — 2.2490 in. | 2.2475 in. | — |
| Clearance | 0.0015 in. — 0.003 in. | 0.0035 in. | Clearances measured vertically. Renew bearings if lead plating is worn through |
| Small-end bush housing, internal diameter | 1.0150 in. — 1.0155 in. | — | — |
| Small-end bush, external diameter | 1.0175 in. — 1.0185 in. | — | Hand push fit in ring gauge |
| Interference | 0.002 in. — 0.0035 in. | — | — |
| Connecting rod and cap bolt holes. Diameter for location | 0.375 in. — 0.3755 in. | — | On location diameter |
| Connecting rod bolt diameter for location | 0.3745 in. — 0.375 in. | — | On location diameter |
| Clearance | Size — 0.001 in. | | |
| Connecting rod bolt diameter | 0.389 in. — 0.391 in. | — | On knurled diameter. Bolts should not be removed from rods unless they are to be renewed |
| Connecting rod and cap bolt holes diameter | 0.380 in. — 0.385 in. | — | |
| Interference | 0.004 in. — 0.011 in. | — | |
| Theoretical nip on connecting rod bearing shells | 0.003 in. — 0.008 in. | — | — |
| Connecting rod end float | 0.008 in. — 0.017 in. | — | Controlled by clearance between rods and crankpin end faces |
| Main bearing shell, internal diameter | | | |
| Theoretical | 2.501 in. — 2.502 in. | | |
| Actual | 2.5015 in. — 2.503 in. | — | Due to housing expansion under interference fit of shells |
| Crankshaft journal diameter | 2.4995 in. — 2.5000 in. | 2.4985 in. | — |
| Clearance (Actual) | 0.0015 in. — 0.0035 in. | 0.0045 in. | Renew bearing if lead plating is worn through |
| Crankshaft end float | 0.004 in. — 0.010 in. | 0.012 in. | — |
| Connecting rod bolt stretch | For 0.005 in. bolt stretch Torque load = 32 lb. ft. | — | — |

| DESCRIPTION | DIMENSION | PERMISSIBLE WORN DIMENSION | REMARKS |
|---|---|---|---|
| **MAIN BEARING HOUSINGS** | | | |
| Bore diameter | 2.6655 in. — 2.6660 in. | — | This diameter should be checked with the main bearing cap nuts in position and torque loaded to 35 lb. ft. |
| **MAIN BEARING CAPS** | | | |
| Width of cap | 5.1005 in. — 5.1010 in. | — | — |
| Gap width | 5.1000 in. — 5.1010 in. | — | — |
| Interference | 0.001 in. minus 0.0015 in. | — | — |
| Cap nuts | Torque load to 45 lb. ft. | | When the bearing shells are in place |
| **VALVE GEAR** | | | |
| Camshaft timing gear backlash | 0.001 in. — 0.0035 in. | 0.005 in. | — |
| True running of camshaft gear face | 0.000 in. — 0.002 in. | — | — |
| Camshaft end float | 0.002 in. — 0.006 in. | — | — |
| Camshaft journal diameter | 1.9975 in. — 1.998 in. | 1.9965 in. | — |
| Camshaft bearing, internal diameter | 2.000 in. — 2.0005 in. | 2.002 in. | — |
| Camshaft journal clearance | 0.002 in. — 0.003 in. | 0.004 in. | — |
| Camshaft bearing, external diameter | 2.129 in. — 2.1305 in. | — | Hand push fit in gauge |
| Crankcase bore — diameter for camshaft bearing | 2.125 in. — 2.1255 in. | — | — |
| Camshaft bearing interference in crankcase | 0.0035 in. — 0.0055 in. | — | — |
| Inlet cam and base circle — overall dimension | 1.465 in. — 1.470 in. | 1.455 in. | Cam lift is 0.250 in. Minimum permissible lift is 0.235 in. |
| Exhaust cam and base circle — overall dimension | 1.465 in. — 1.470 in. | 1.455 in. | Cam lift is 0.250 in. Minimum permissible lift is 0.235 in. |
| Tappet block bore diameter | Y. 0.90475 in. — 0.9050 in. | — | — |
| | Z. 0.9050 in. — 0.90525 in. | — | — |
| Tappet external diameter | Y. 0.9040 in. — 0.90425 in. | — | — |
| | Z. 0.90425 in. — 0.9045 in. | — | — |
| Clearance | 0.0005 in. — 0.001 in. | 0.0015 in. | — |
| Tappet 'leak-down' test | Time for a plunger travel of $\frac{1}{8}$ in. under a load of 50 lb. is 10-45 sec. | — | This 'leak-down' time is critical and any tappet outside these figures should be replaced with a complete assembly. Parts must not be interchanged |

| DESCRIPTION | DIMENSION | PERMISSIBLE WORN DIMENSION | REMARKS |
|---|---|---|---|
| Exhaust valve guide — external diameter | 0.6275 in. — 0.628 in. | — | — |
| Cylinder head bore diameter for exhaust valve guide | 0.625 in. — 0.626 in. | — | — |
| Interference in head | 0.0015 in. — 0.003 in. | — | — |
| Exhaust valve guide — internal diameter | 0.3755 in. — 0.376 in. | 0.378 in. | 'Bellmouth' at the lower end is permissible up to 0.006 in. for a depth of 0.375 in. |
| Exhaust valve stem diameter | 0.37175 in. — 0.372 in. | 0.3705 in. | — |
| Clearance | 0.0035 in. — 0.00425 in. | 0.0060 in. | — |
| Exhaust valve spring compressed to 1.600 in. | 82 — 86 lb. | 71 lb. | — |
| Exhaust and inlet valve seat angle | 45° minus 1/10° | — | 'Crown' with 30° cutter to avoid pocketing after regrinding seat |
| Exhaust valve seat insert — external diameter | 1.7540 in. — 1.7545 in. | — | — |
| Cylinder head bore diameter for seat insert | 1.750 in. — 1.751 in. | — | — |
| Interference | 0.003 in. — 0.0045 in. | — | — |
| Inlet valve seat insert, external diameter | 2.0290 in. — 2.0295 in. | — | — |
| Cylinder head bore diameter for seat insert | 2.025 in. — 2.026 in. | — | — |
| Interference | 0.003 in. — 0.0045 in. | — | — |
| Inlet valve guide, external diameter | 0.6275 in. — 0.628 in. | — | — |
| Cylinder head bore diameter for inlet valve guide | 0.625 in. — 0.626 in. | — | — |
| Interference in head | 0.0015 in. — 0.003 in. | — | — |
| Inlet valve guide, internal diameter | 0.3755 in. — 0.376 in. | 0.3773 in. | — |
| Inlet valve stem diameter | 0.3735 in. — 0.374 in. | 0.3723 in. | — |
| Clearance | 0.0015 in. — 0.0025 in. | 0.005 in. | — |
| Inlet valve spring compressed to 1.600 in. | 82 — 86 lb. | 71 lb. | — |
| Exhaust valve — overall length | 5.033 in. | — | — |
| Inlet valve — overall length | 5.075 in. | — | — |
| Distributor gear backlash | 0.002 in. — 0.004 in. | 0.008 in. | — |

| DESCRIPTION | DIMENSION | PERMISSIBLE WORN DIMENSION | REMARKS | |
|---|---|---|---|---|
| Rocker bush — internal diameter | 0.7495 in. — 0.74975 in. | 0.751 in. | — | Early S2 Engines |
| Rocker shaft diameter | 0.74825 in. — 0.7485 in. | — | — | |
| Clearance | 0.001 in. — 0.0015 in. | 0.0035 in. | — | |
| Rocker bush — external diameter | 0.845 in. — 0.846 in. | — | Hand push fit in gauge | |
| Rocker bore diameter for bush | 0.84275 in. — 0.84325 in. | — | — | |
| Interference | 0.00175 in. — 0.00325 in. | — | — | |
| Rocker bore diameter | 0.74925 in. — 0.74975 in. | 0.751 in. | — | Late S2 Engines |
| Rocker shaft diameter | 0.7485 in. — 0.74825 in. | — | — | |
| Clearance | 0.001 in. — 0.00125 in. | 0.0035 in. | — | |
| **OIL PUMP** | | | | |
| Driving shaft diameter | 0.4990 in. — 0.4995 in. | 0.4970 in. | — | |
| Shaft bore diameter | 0.500 in. — 0.5005 in. | — | — | |
| Shaft clearance in casing bore | 0.0005 in. — 0.0015 in. | 0.003 in. | — | |
| Stationary spindle diameter | 0.499 in. — 0.4995 in. | 0.4965 in. | — | |
| Driven gear bush — internal diameter | 0.500 in. — 0.5005 in. | 0.5015 in. | — | |
| Clearance on spindle | 0.0005 in. — 0.0015 in. | 0.003 in. | Permissible only when the radial clearance of the gears in the case exceeds this figure | |
| Driven gear bush, external diameter | 0.626 in. — 0.6265 in. | — | — | |
| Driven gear—internal diameter | 0.625 in. — 0.6255 in. | — | — | |
| Interference | 0.0005 in. — 0.0015 in. | — | — | |
| Diametrical clearance between gears and side of chamber | 0.0020 in. — 0.0035 in. | 0.006 in. | — | |
| Pump gears — backlash | 0.0005 in. — 0.0025 in. | 0.004 in. | — | |
| Pump gears — end float | 0.001 in. — 0.004 in. | 0.005 in. | — | |
| Drive gear backlash | 0.0012 in. — 0.0033 in. | 0.008 in. | — | |
| **CYLINDER HEAD STUDS** Stud diameter | Yellow 0.405 in.—0.404 in.<br>Red 0.404 in.—0.403 in.<br>Blue 0.403 in.—0.4019 in. | — | Studs must be matched to hole, colour for colour | |

| DESCRIPTION | DIMENSION | PERMISSIBLE WORN DIMENSION | REMARKS |
|---|---|---|---|
| Threaded hole diameter | Yellow 0.404 in.—0.403 in.<br>Red 0.403 in.—0.402 in.<br>Blue 0.402 in.—0.401 in. | — | Studs must be matched to hole, colour for colour. |
| Interference | 0.000 in. to 0.002 in. | | |
| **MAIN BEARING HOUSING STUDS** | | | |
| Stud diameter | Yellow 0.4675in.-0.4665in.<br>Red 0.4665 in.—0.4655 in.<br>Blue 0.4655 in.—0.4643 in. | — | Studs must be matched to hole, colour for colour |
| Threaded hole diameter | Yellow 0.4665in.-0.4655in.<br>Red 0.4655 in.—0.4645 in.<br>Blue 0.4645 in.—0.4635 in. | | |
| Interference | 0.000 in. to 0.002 in. | | |

**OIL PUMP RIG TEST PERFORMANCE**

Oil temperature to be 80°C. (176°F.).

| Pump R.P.M. | Restricting Orifice Diameter (inches) | Permissible Minimum Pressure (lb./ sq. in.) |
|---|---|---|
| 500 | 0.150 — 0.002 | 32 |
| 1,000 | 0.150 — 0.002 | 37 |
| 1,500 | 0.150 — 0.002 | 40 |
| 180 | 0.100 — 0.002 | 25 minimum |

**OIL PUMP RELIEF VALVE SPRING**

Free length — 1.975 in.

Load when compressed to 1.125 in. — 11½ lb.

# Section E4

# ENGINE

## General description

The Rolls-Royce power unit is an over square 'V' engine, having eight cylinders and operating on the four-stroke cycle. It has a bore of 4.100 in. and a stroke of 3.600 in., giving a total capacity of 380.200 cu. in. (6,230 c.c.). The compression ratio of the power unit is 8.00:1.

The engine and gearbox are mounted as a single unit in the chassis frame. Suspension of the unit is provided by a three-point rubber-mounting system; a single point at the front, under the sump, and two points at the rear, one on either side of the clutch casing. This system provides insulation and a degree of controlled flexibility.

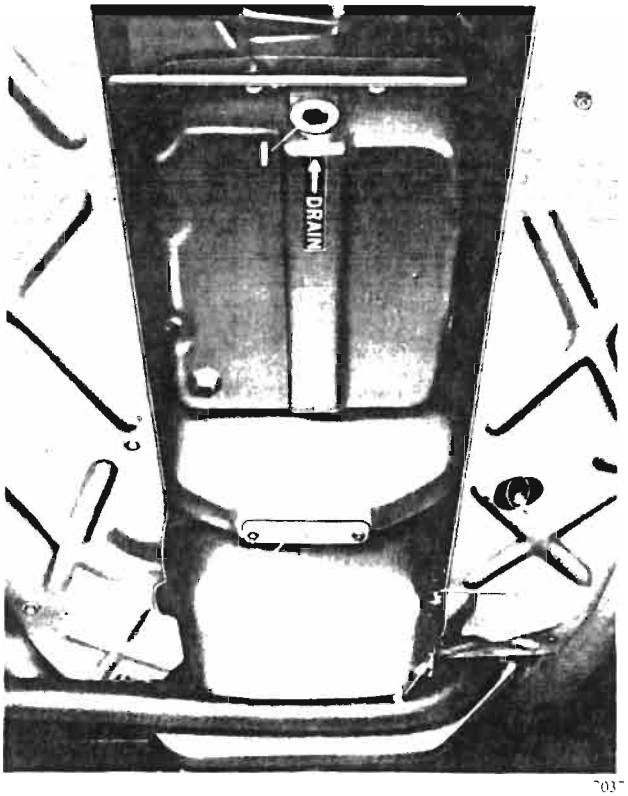
The aluminium monobloc casting, comprising crankcase and eight cylinders, incorporates detachable, full-length, wet liners of centrifugally spun cast iron. The cylinders are arranged in two banks of four and are inclined at an angle of 90 deg. to each other, the centre line of each 'B' bank cylinder being slightly behind that of the corresponding 'A' bank cylinder.

The dynamically balanced crankshaft is a forging of chrome molybdenum steel, provided with integral balance weights; it is carried in five bearings. These bearings consist of thin steel shells, lined with copper lead-indium; the bearings are held in position by forged aluminium bearing caps. Crankshaft end thrust is taken by the centre main bearing, which is fitted with thrust pads at both front and rear.

The 'H' section connecting rods and caps are forged to size from either chrome molybdenum or low nickel chrome molybdenum steels. The gudgeon pin bushes, which are pressed into the small-end boss to give an interference fit, are of lead-bronze on a steel backing. The big-end bearings are thin steel shells lined with copper lead-indium.

Aluminium alloy pistons, with full skirts and recessed crowns, are carried on hardened steel gudgeon pins, which are retained in the pistons by two circlips. Four rings are fitted to each piston — three compression rings and one scraper ring.

The cylinder heads of cast aluminium carry the overhead inlet and exhaust valves. These valves are positioned in line and run in valve guides pressed into the heads. The valves are operated through hydraulic tappets, push rods and rockers from a centrally positioned camshaft, which is carried in four white metal bearings. The hydraulic tappets are carried in detachable blocks located inside the crankcase.




1 GEARBOX DRAIN PLUG
2 TIMING INSPECTION COVER
3 ENGINE DRAIN PLUG
4 OIL LEVEL GAUGE

**Fig. E8 Engine and gearbox drain plugs**

Air is filtered through a dry micronic paper filter element, before being drawn through the carburetters. The carburetters are mounted on a 'T' piece over an eight-branch induction manifold. An automatic choke mechanism is provided for cold starting.

Lubrication is provided by a pressurized system. First-stage filtration is through a fine mesh strainer and pick-up, before the oil passes through the pump. Final filtration is through a 'British' Full-Flow type filter under pressure

**To remove as a unit with the gearbox**

The engine and gearbox should be removed from the chassis frame as a unit, adopting the following procedure.

Disconnect the leads from the battery terminals.

Evacuate the refrigeration system and disconnect the pipes from the compressor unit. For detailed instructions on discharging the system, refer to the Air Conditioning Manual.

Remove any dirt from around the sump drain plug, place a suitable container in position, then remove the drain plug and allow the engine oil to drain; it is advisable to carry out this operation when the engine is warm. When completely drained, refit the drain plug (see Fig. E8).

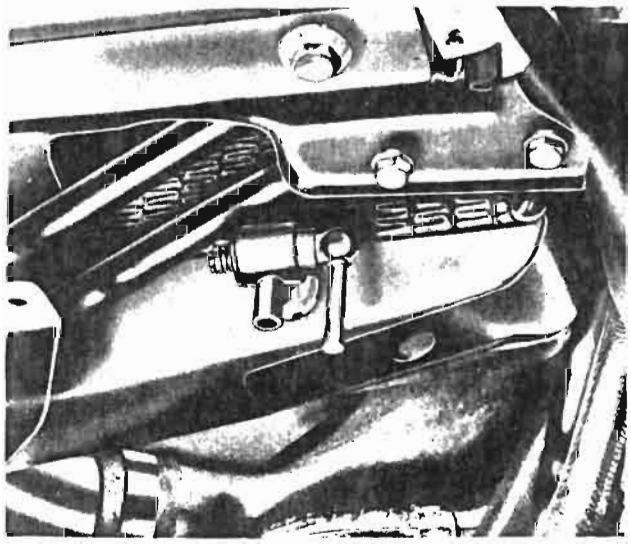


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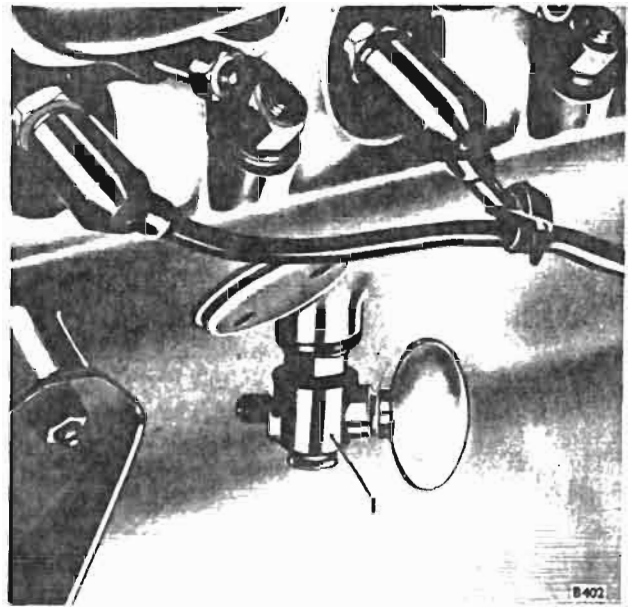
**Fig. E9 Radiator drain tap**



1 DRAIN TAP

**Fig. E10 Cylinder block drain tap**

Drain the cooling system. Three drain taps are provided, one on the radiator and one on each side of the engine crankcase (see Fig. E9 and E10). If the cooling system contains anti-freeze and it is intended to use it again, the coolant should be drained into a suitable container and stored.

Disconnect and remove the air silencer unit and hosing.

Remove the bonnet.

Remove the front apron and radiator shell as an assembly.

Disconnect the heater and demister pipes from the cylinder heads and the hoses from the cooling system.

Remove the retaining bolts and lift out the matrix and fan blade shield. Remove the matrix stays and the support assembly as a single unit.

Disconnect the exhaust pipes from the manifolds and remove the exhaust manifolds and gaskets.

Remove the undersheets from the chassis.

Disconnect the wiring connections and piping, then remove the windscreen washer bottle and motor (see Fig. E12).

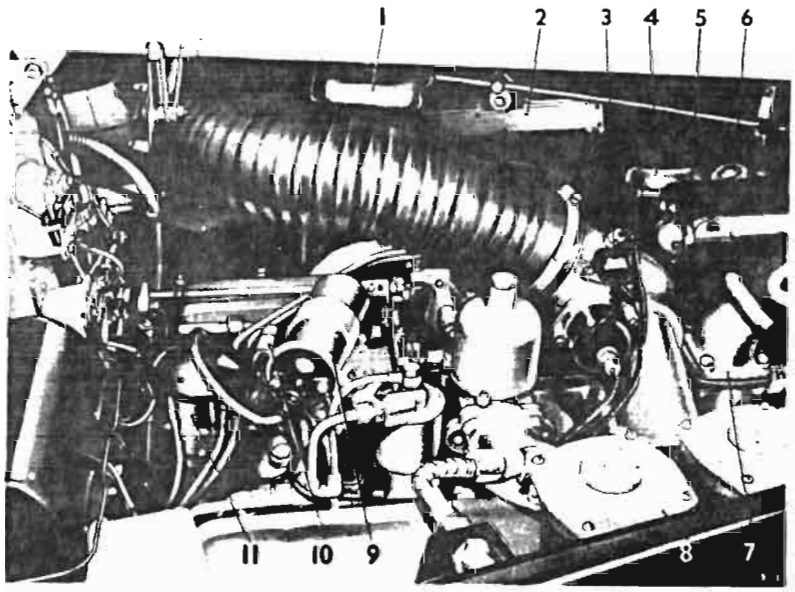
The electrical wiring is carried in a loom which is clipped to the induction manifold. Disconnect the wires at the following points on the engine:

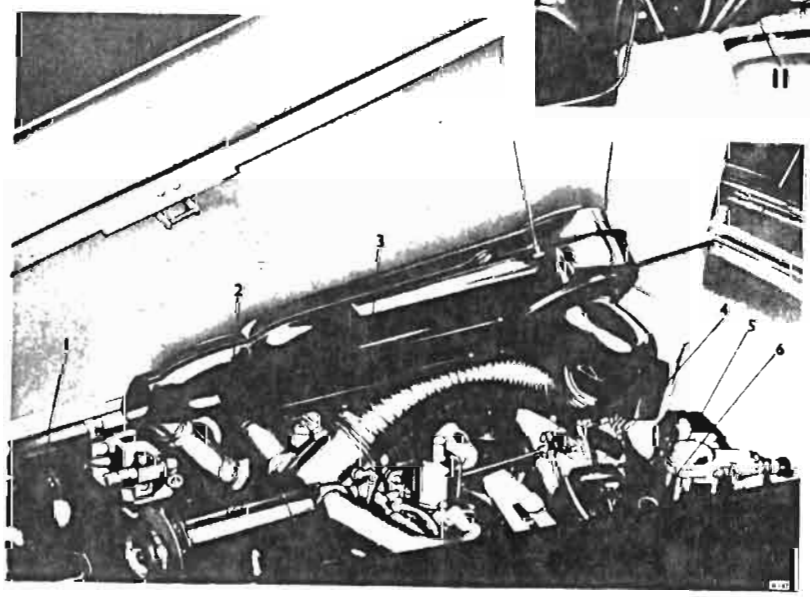
Coolant temperature indicator.
Generator terminals.
Automatic choke solenoid (see Fig. E11).
Oil pressure gauge (see Fig. E13).
Oil level gauge (see Fig. E8).
Starter motor (see Fig. E14).
Ignition coil.

The flexible supply pipe from the fuel pump should be disconnected at the union situated at the rear of 'A' bank cylinder head.

1 WINDSCREEN WASHER RESERVOIR
2 BONNET LOCKING MECHANISM
3 AUTOMATIC CHOKE SOLENOID
4 ENGINE OIL FILLER CAP
5 GENERATOR
6 STEERING PUMP
7 THERMOSTAT HOUSING
8 BRAKE FLUID RESERVOIRS
9 IGNITION COIL
10 IGNITION CONDENSER
11 IGNITION DISTRIBUTOR

**Fig. E11 General view of R.H. side of engine**




1 RADIATOR FILLER CAP
2 GENERATOR
3 AIR CLEANER AND SILENCER
4 WINDSCREEN WASHER MOTOR
5 WINDSCREEN WIPER MOTOR AND MECHANISM
6 ENGINE DIPSTICK

**Fig. E12 General view of L.H. side of engine**

Disconnect the throttle linkage from the carburetters.

Disconnect the throttle control valve linkage and the gear change linkage from the gearbox.

Detach the two rubber pipes for the vacuum lines from the induction manifold. (Applicable to Phantom V, Long Wheelbase and Bentley Continental cars.)

Remove the brake servo mechanism from the rear end of the gearbox.

Disconnect the speedometer drive cable from the gearbox.

Disconnect the pipes at the unions on the power-assisted steering pump reservoir and drain the fluid into a suitable container.

Remove the nuts and bolts securing the universal joint to the gearbox output flange, and break the connection.

Remove the dipstick and the dipstick tube from the engine sump.

Fig. E13 Oil filter and oil pressure gauge

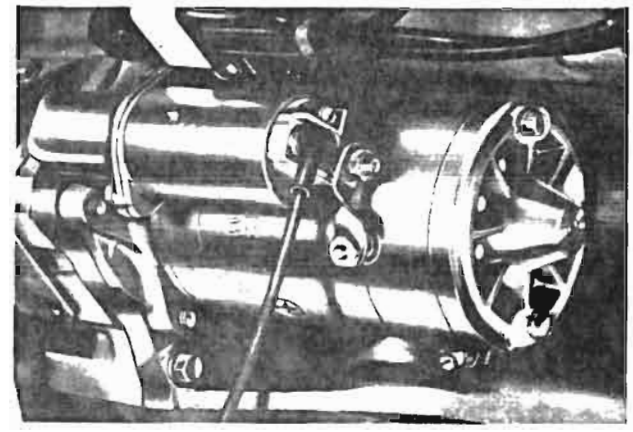


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Fig. E14 Starter motor

Place two slings around the engine; one at the front of the crankcase and the other at the rear of the bellhousing. The front sling should be considerably shorter than the rear one so that the rear end is lower than the front when the engine is being lifted from the frame. Take the weight of the engine and the gearbox unit with the slings.

Remove the bolts and setscrews securing the engine front mounting and the setscrews securing the two rear mountings.

Carefully check that all hoses, pipes and cables are disconnected and that nothing impedes the removal of the engine.

Lift the engine and gearbox out of the frame.

**To fit as a unit**

When installing the engine and gearbox as a unit in the frame, reverse the procedure adopted for removal, noting the following points.

Renewal of all exhaust gaskets.

All hoses showing signs of deterioration should be renewed.

Before starting the engine, ensure that the engine is refilled with fresh oil.

Ensure that the cooling system is replenished.

Finally, connect the battery leads.

## Section E5

# CRANKCASE AND CYLINDER LINERS

**Description**

The crankcase and cylinders form a monobloc casting which carries wet-type cylinder liners; the liners are sealed at the top by a single 'O' ring and at the bottom by two 'O' rings.

Four split-type camshaft bearings are also fitted in the crankcase.

The main bearing caps of forged aluminium have an interference fit in the crankcase of 0.0015 in.

Cast iron tappet blocks are located by two dowels fitted in the crankcase; one of the dowel locating holes in the tappet block is elongated to form a slot which allows for the different rates of expansion of the two metals, caused when the engine is hot.

The bores of the tappet blocks are graded into two sizes and a code letter is etched on the top of each bore (see Engine Data).

Core plugs are fitted in order to provide access to the coolant jackets for cleaning purposes.

The threads of all studs fitted into the crankcase have an interference fit of 0.000 in. to 0.002 in. as quoted in the Engine Data.

All setscrew holes are fitted with helicoil inserts and the threads into which these helicoils are screwed are non-standard sizes, therefore no attempt should be made to fit setscrews into threaded holes where helicoils are not fitted.

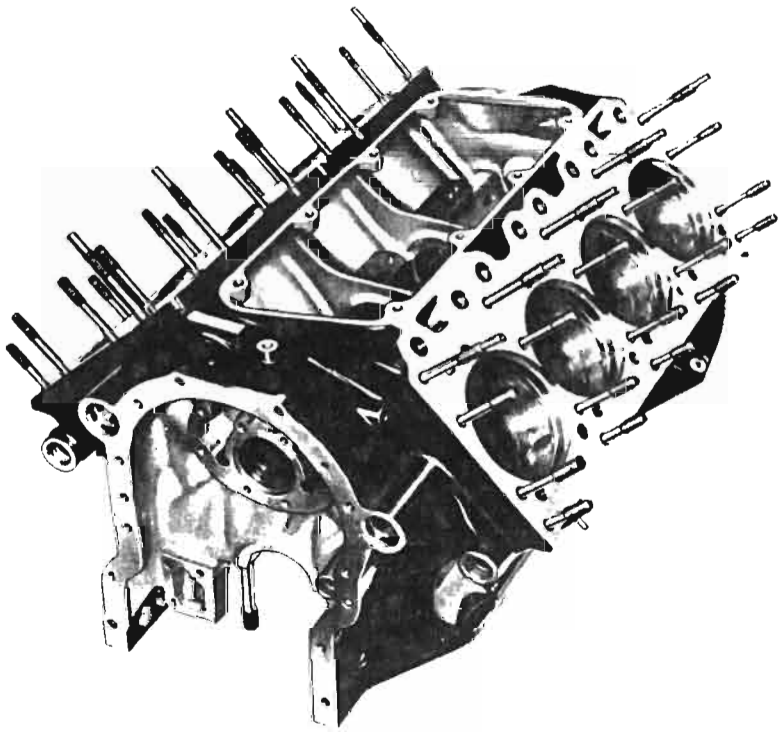

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Fig. E15 Crankcase

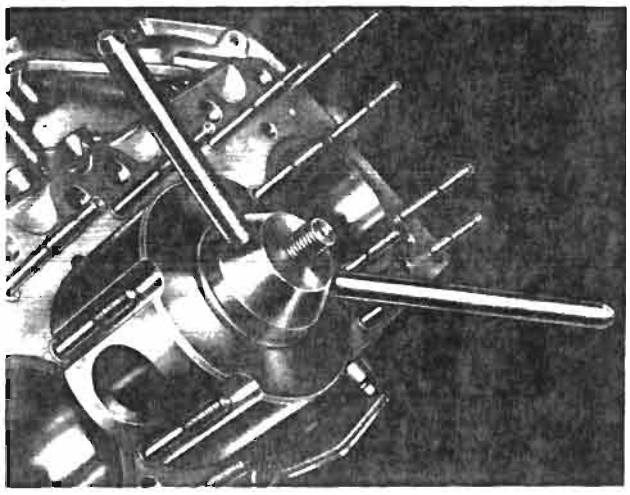

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Fig. E16 Method of removing cylinder liner using tool No. RH.7095

**Cylinder liners — To remove**

If the cylinder liner bores show wear in excess of 0.004 in., or ovality in excess of 0.003 in., the liners should be withdrawn and new liners and pistons fitted.

The bore dimensions must only be checked when the liner is fitted to the crankcase.

Withdraw the liner from the crankcase, using the liner extraction tool (No. R.H.7095), as shown in Fig. E16.

The liner is only removable from the top face of the crankcase.

**Cylinder liners — To fit**

Before commencing to fit a new liner, ensure that both the liner and the bore are perfectly clean, as dirt may prevent the liner seating correctly in the crankcase.

Fit the liner into the bore and check that it can be rotated freely.

Check that the liner stands 0.002 in. to 0.003 in. 'proud' of the face of the crankcase. This will give the correct amount of 'nip' on the liner when the cylinder head is fitted (see Fig. E17).

Remove the liner and check that the coolant drain hole is not obstructed; this hole is situated between the locating grooves for the two bottom sealing rings.

Examine the sealing rings for distortion or deterioration and if in a serviceable condition the rings may be used again, otherwise new rings should be fitted.

To facilitate easy entry of the liner into the bore, lightly smear the sealing rings with engine oil before they are fitted in the crankcase.

To enable each liner to be identified with its bore, the number of the bore is etched on the top edge of the liner; when fitting the liner this marking should be opposite the coolant hole on the top edge of the crankcase face.

Lightly smear oil on the outside diameter, at the bottom of the liner, then carefully enter it into its

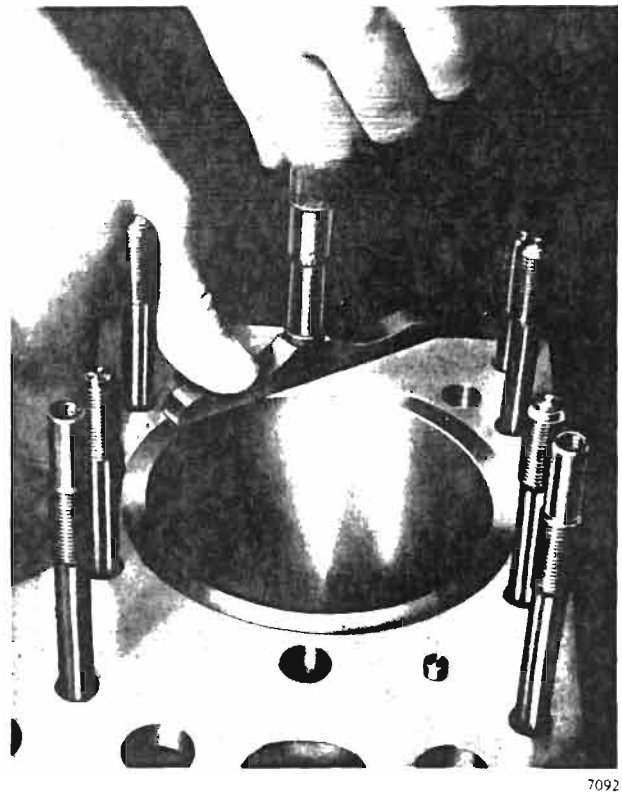

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Fig. E17 Checking cylinder liner 'nip'

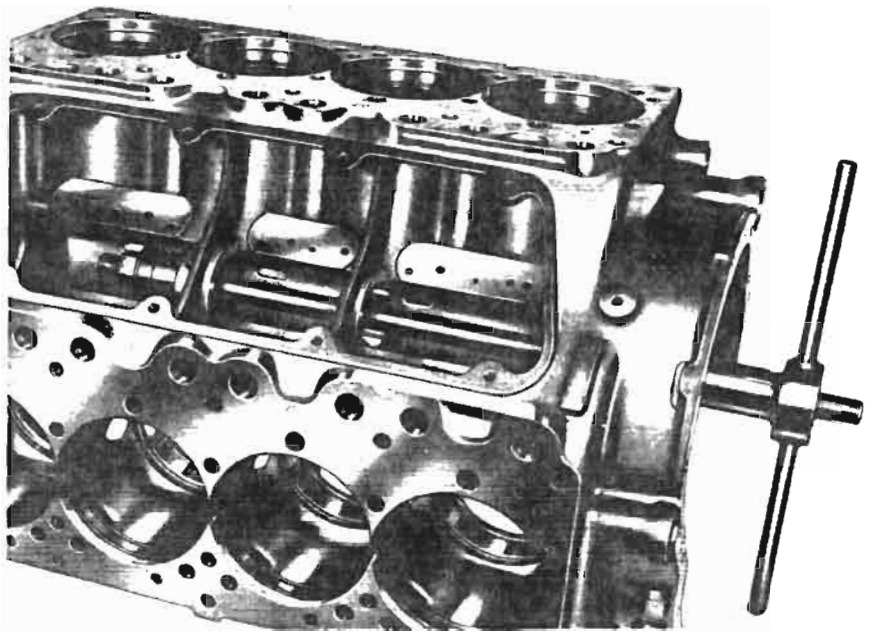

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**Fig. E18 Removal of camshaft bearings**

bore and gently 'work' it down until it becomes tight; care should be taken to ensure that the top sealing ring is not dislodged from its groove.

Tap the liner down to ensure that it is completely 'home'. Place a block of wood across the top of the liner to avoid damaging the bore during this operation.

Finally, again check for 'nip'.

**Camshaft bearings — To remove**

The maximum permissible clearance between the camshaft journals and bearings is 0.004 in. If this figure is exceeded the camshaft bearings should be removed, using the special tool (No. RH.7096), shown in Figure E18.

**Camshaft bearings — To fit**

Clean the camshaft bearing bores in the crankcase and check the diameters. This reading should not exceed 2.1255 in. Fit the new bearings, using the special tool (No. RH.7096). The bearings should be drawn in from the rear of the crankcase and with the chamfered edge leading. If the front bearing is fitted correctly, the split should be towards the top and at 21 deg. from the vertical datum. Similarly, the two intermediate bearings should be fitted with the splits towards the top and at 14 deg. from the vertical. The rear bearing should have the split at the top in the vertical plane. With the bearings positioned thus, all the oil holes in the bearings will line up with the oil passages in the crankcase.

The bearings should be finish-line-reamed with the camshaft bearing line reaming tool (No. RH.7109). The finished diameter should be 2.000 in. to 2.0005 in. Thoroughly clean the crankcase and remove all the swarf before further assembly of the engine.

In isolated cases, loss of oil down the crankcase breather pipe on early S2 engines has occurred.

The oil loss was caused by the camshaft flinging oil through a gap which existed between the breather baffle and the wall of the crankcase.

The following modification was carried out.

The baffle plate was removed and the bottom edge relieved to ensure that it cleared the boss formed by the camshaft bearing (see 'A' fig. 18a). The baffle plate was refitted into position and was bent as necessary to ensure that it fitted flush against the wall of the crankcase.

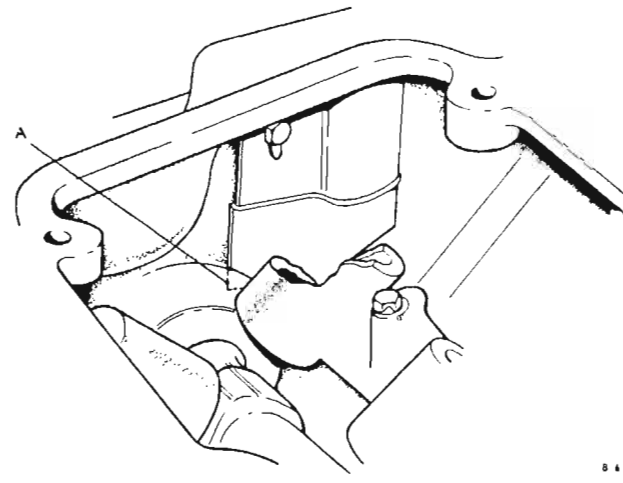


**Fig. 18a Modified baffle shown in position. 'A'. Area of metal removed.**

# Section E6

# ENGINE LUBRICATION

**For information**

Three different methods of feeding oil to the camshaft bearings have been employed. The differences involve slight modifications to the camshaft and crankcase (see Fig. E19).

To ascertain which stage camshaft is fitted to a particular engine, reference should be made to Service Bulletin S2/E1.

The camshaft fitted to engines employing stage 1 lubrication cannot be fitted to engines employing stages 2 and 3 lubrication. Likewise, camshafts fitted to engines with stages 2 and 3 lubrication systems cannot be fitted to engines having stage 1 lubrication, unless the crankcases are modified to suit.

Stages 2 and 3 are basically the same and the camshafts fitted to engines having either of these lubrication systems may be interchanged.

The three stages are described as follows.

**Description**

***All stages***

Lubrication of the engine is by a pressure-fed wet sump system incorporating Full-Flow filtration of the oil. Circulation of the oil is effected by an oil pump employing helical displacement gears, driven by the crankshaft at half engine speed. (For oil pump performance figures see Engine Data.) The cylinder walls and gudgeon pins are lubricated by oil splash and mist thrown up by the crankshaft.

Oil is drawn from the sump through a pick-up, fitted with a fine mesh gauze strainer which ensures delivery of clean oil to the pump from where it is delivered to the Full-Flow oil filter.

The filtered oil then passes through a drilling in the crankcase to a small pocket around the front end of the camshaft (an end plate which covers this pocket also provides end location for the camshaft); the oil then feeds from this pocket to the main galleries.

The two main oil galleries are situated one on either side of the camshaft and extend along the full length of the crankcase; from these galleries the oil feeds to the tappet blocks and through drillings in the crankcase webs, to the main bearings. Number 1, 3 and 5 main bearings are fed from the 'B' bank oil gallery and number 2 and 4 from the 'A' bank gallery.

Oil is transferred from the main bearings, through angular drillings in the crankshaft webs, to the big-end bearings, from where it drains into the sump.

The cylinder walls are lubricated by splash from the crankshaft. Lubrication of the gudgeon pin and bush is also by splash and mist; oil collecting on the inside of the piston crown drips on to the connecting rod small-end and passes through a drilling to the bush and gudgeon pin.

Oil which is fed to the tappet blocks, passes through a drilling in the bore of the tappet block and into a small groove machined around the periphery of the tappet barrel. From this groove it passes through a feed hole into the tappet, thus keeping the tappet primed. The oil then passes up the hollow push rod to lubricate the push rod ball-end and the seating in the rocker arm.

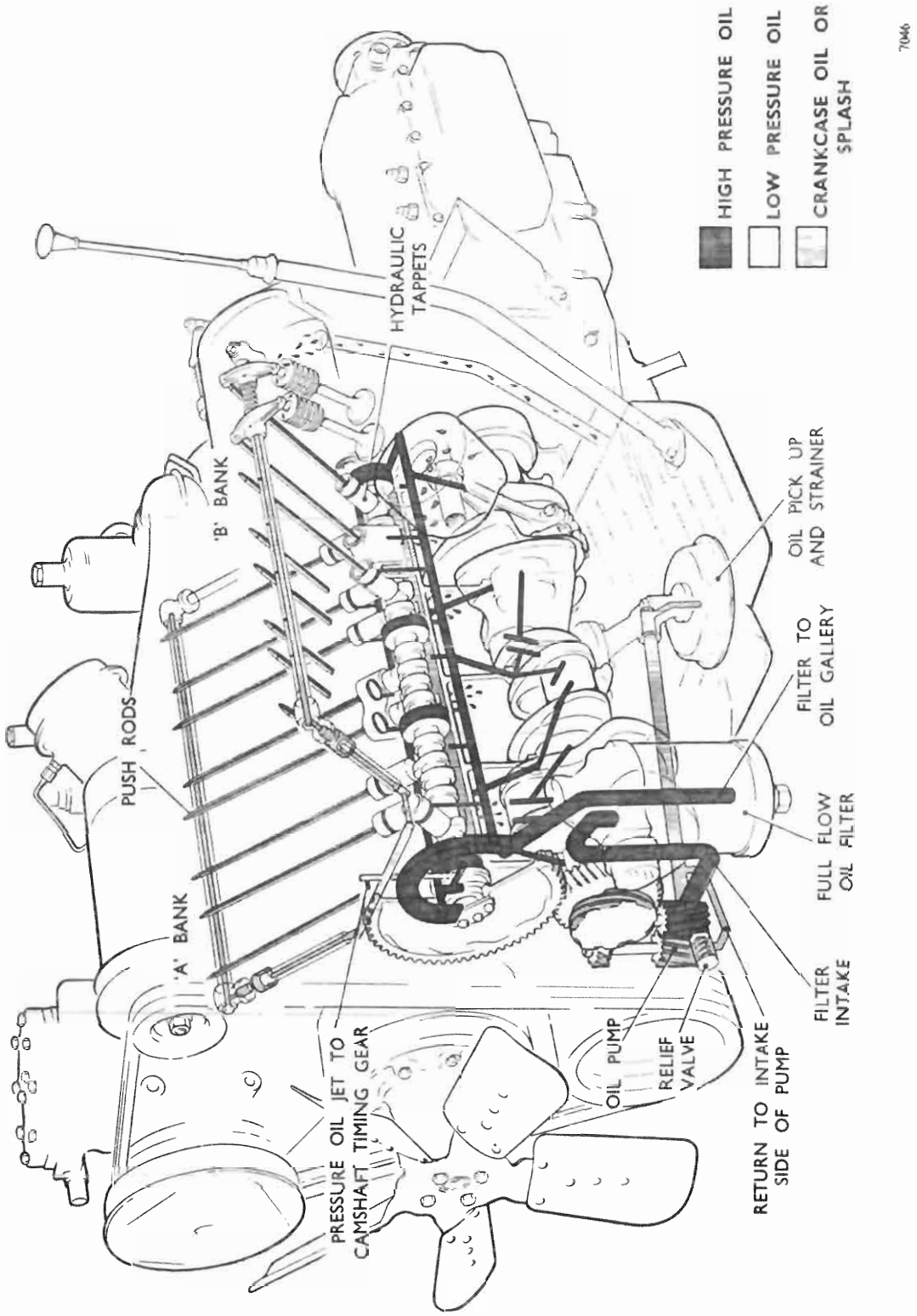


Fig. E19 Engine lubrication diagram

*Stage 1*

A drilling in the 'A' bank oil gallery feeds oil to the front camshaft bearing. In the front camshaft journal is a further drilling and as the camshaft rotates this drilling picks up oil from the bearing feed and transmits the oil to the partly hollow camshaft. The camshaft is drilled from the front end as far as number three journal; the front end being plugged.

Rotation of the camshaft when full of oil causes a build-up of pressure to approximately 5 lb./sq. in., thus causing the oil to feed through number 2 and 3 journals to the camshaft bearings and then into a trough situated beneath the camshaft. From the trough the oil is picked up by the cams as the camshaft rotates and provides lubrication for the bearing faces of the cams and tappets.

Lubrication of the rear camshaft bearing and journal (No. 4) is provided by a tapping off 'B' bank main oil gallery. Oil drains from this bearing to provide lubrication for the camshaft and distributor skew gears.

As the camshaft rotates, the drilling in the front journal lines up with a vertical drilling in the crankcase and allows oil to feed to a horizontal drilling in the crankcase. From this horizontal drilling the oil passes through to the cylinder head studs, to which the rocker shaft is secured. These two front studs are hollow and the oil passes up them into the rocker pedestals and then into the hollow rocker shaft.

A small tapping, off the vertical drilling in the crankcase, provides lubrication for the camshaft timing wheel and driving pinion in the form of an oil jet which sprays on to the top of the timing wheel. The oil then drains back to the sump.

Oil from the rocker shaft passes through drillings in the rockers and bushes and runs down the rocker arms to lubricate the rocker pads and valve tips. The oil is then returned to the sump through drain holes in the cylinder heads and crankcase.

*Stages 2 and 3*

A drilling in the 'A' bank oil gallery feeds oil to the front camshaft bearing. In the front camshaft journal are two further drillings, at right angles to each other and as the camshaft rotates these drillings pick up oil from the bearing feed and feed it to a vertical drilling in the crankcase; this drilling feeds into a further horizontal drilling in the crankcase. From this point the oil passes through to the two front cylinder head studs, on which the rocker shaft pedestals are mounted; these two studs are hollow and the oil passes up them to the rocker pedestals and then into the hollow rocker shaft.

A small tapping off the vertical drilling in the crankcase provides lubrication for the camshaft timing wheel and driving pinion in the form of a jet of oil on to the top of the timing wheel. The oil then drains back to the sump.

Lubrication of the intermediate and rear camshaft bearings and journals is via drillings from the 'B' bank main oil gallery. Oil from the rear bearing drains to provide lubrication for the camshaft and distributor skew gears. Oil from the

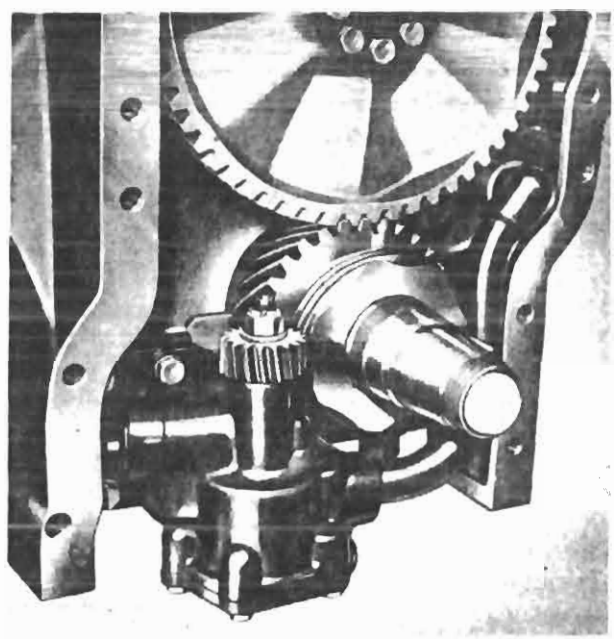

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**Fig. E20 View of oil pump fitted to engine**

intermediate bearings, numbers 2 and 3, drains into a trough beneath the camshaft. Oil from this trough is 'picked-up' by the cams as the camshaft rotates, thereby providing lubrication for the bearing faces of the cams and tappets.

Oil from the rocker shaft passes through drillings in the shaft to the rocker bores and then through further drillings to the outside of the rocker arms; it then runs down the arms to lubricate the rocker pads and valve tips. The oil then returns to the sump through drain holes in the cylinder heads and the crankcase.

### Oil pump

The helical displacement gear pump is positioned in the lower front end of the engine and is driven by the crankshaft through skew gears. It is attached to the crankcase by three setscrews (see Fig. E20).

The casing and cover of the pump are of cast iron and enclose two steel helical gears. The pump driving gear and shaft are machined as one; the bronze skew gear, which is driven by the crankshaft gear, is keyed to the end of the shaft; no bush is fitted to the pump casing for this shaft.

The oil pump driven gear has a pressed-in bush and runs on a steel spindle pressed into the pump casing.

***Oil relief valve*** (see Fig. E21)

An oil relief valve, incorporated in the oil pump, is designed to relieve pressure by allowing oil to return to the inlet side of the pump should pressure exceed 40 lb./sq. in.

This valve consists of a brass seating pressed into the pump body and a pressed steel disc valve which is held on to this seating by a coil spring;

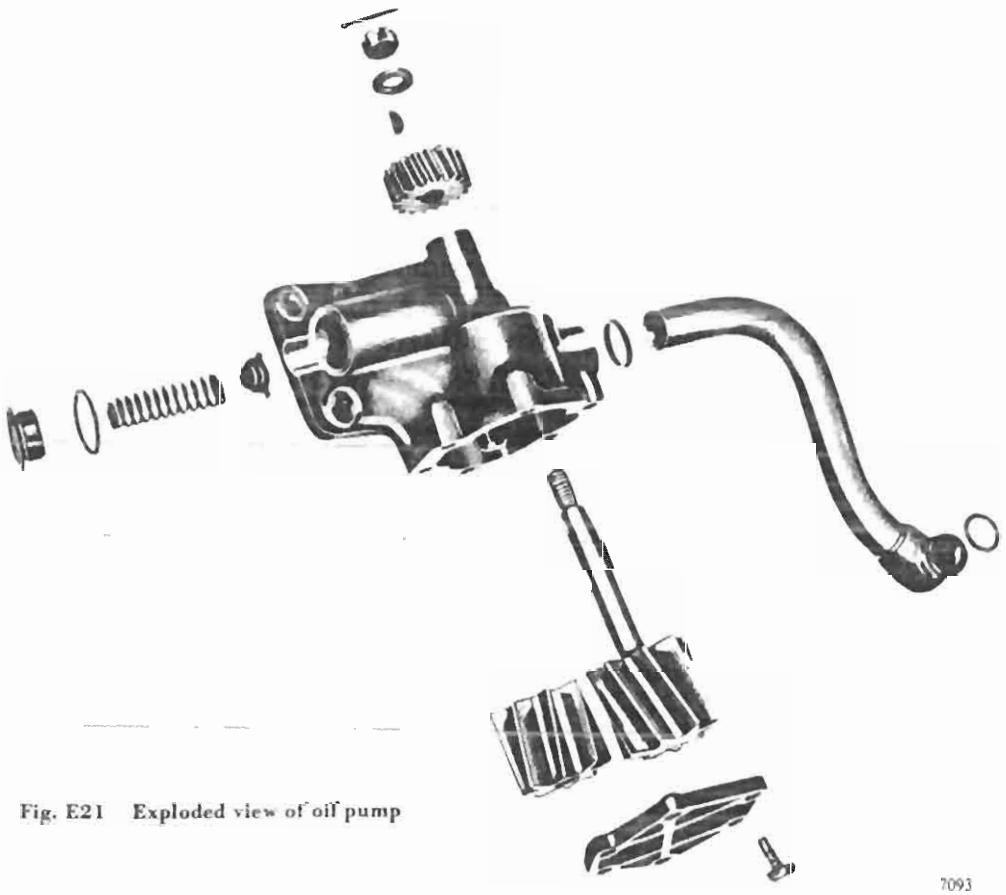

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**Fig. E21 Exploded view of oil pump**

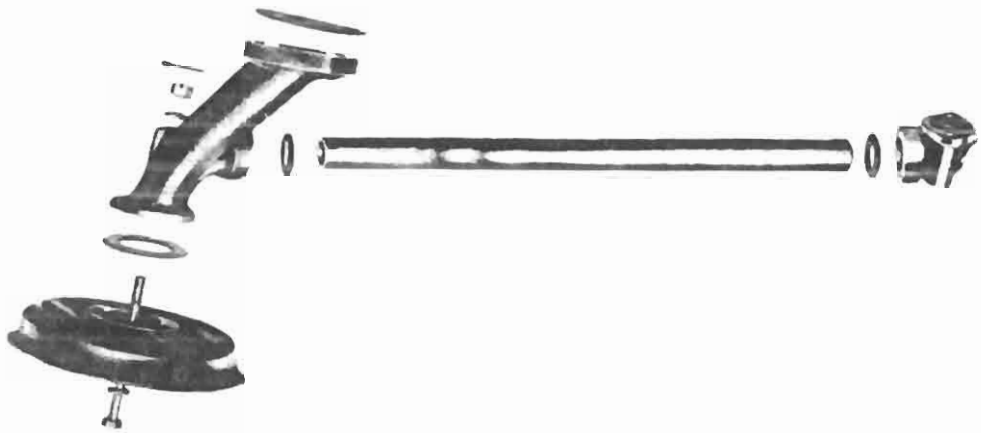

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Fig. E22 Exploded view of fine mesh strainer and pick-up

the spring is retained by an end plug which is screwed into the body by means of a two-pronged spanner.

**Oil pump — To remove**

To enable the oil pump to be removed from the engine, it is necessary to remove the sump and to dismantle the front end of the engine as follows:

Remove all driving belts from the crankshaft pulley and remove the generator and water pump. Unscrew the five setscrews and detach the crankshaft pulley and the Metalastik damper which are located by two dowels to the driving flange.

Remove the nut and washer securing the driving flange to the crankshaft, and withdraw the flange by means of the withdrawal tool RH.7097 shown in Figure E23.

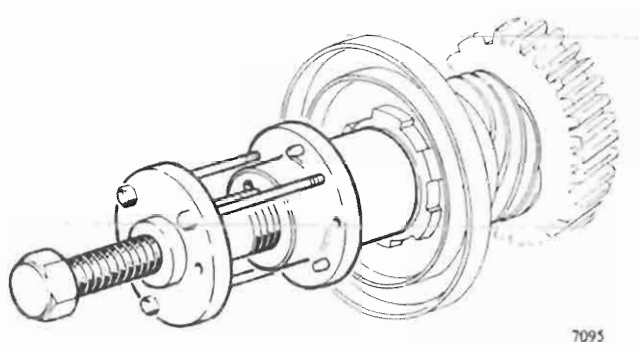

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Fig. E23 Withdrawal of crankshaft driving flange

Unscrew the setscrews securing the lower front cover, which is also located by two dowel inserts, then remove the cover.

Remove the oil pipe connecting the pump to the filter intake, ensuring that the rubber 'O' ring, fitted at the filter intake end of the pipe, is also removed.

Unscrew the three setscrews securing the pump to the crankcase, then remove the pump together with the two dowel inserts.

**Oil pump — To fit**

To fit the oil pump to the engine, reverse the procedure given for its removal, noting the following points.

Ensure that the backlash between the driving gear on the crankshaft and the gear on the pump driving shaft is between 0.0012 in. and 0.0033 in. (see Fig. 24).

Fit new joints to the lower front cover and to the oil pump facing.

Renew the Neoprene seal between the water pump casing and the lower front cover, also the delivery pipe 'O' rings.

The oil delivery pipe is held in position by means of a rubber pad attached to the front cover; ensure that this pad is in position before fitting the cover.

When refitting the setscrews securing the pump to the engine, ensure that the dowel inserts are fitted to the holes from which they were removed.

**Oil pump — To dismantle**

Hold the external driving gear in a suitable fixture, taking care that sufficient protection is provided to ensure that the teeth of the gear are not damaged.

Remove the split pin, nut and washer securing the gear to the driving shaft, then withdraw the gear, using a suitable withdrawal tool; remove the Woodruff key from the shaft.

Unscrew the setscrews and remove the end cover from the pump, then withdraw the two gears from the pump casing.

**Oil pump — To assemble**

Before commencing to assemble the oil pump it is essential that care be taken to ensure that all parts are perfectly clean.

Reverse the procedure given for dismantling, noting the following points.

Examine all working parts for wear and inspect the end cover and casing for distortion; renew if necessary.

If it is necessary to renew the bush in the driven gear, remove the bush and press in a new one; the bush should then be reamed to 0.500 in. ± 0.0005 in.

Assemble the oil pump and check the end float of the gears; this should be between 0.001 in. and 0.004 in. but the permissible tolerance allowed for wear is 0.007 in

Excessive end float may be reduced by facing-off the necessary amount from the joint face of the pump casing.

Ensure that the backlash between the pump driving gear and the driven gear is between 0.0005 in and 0.0025 in.

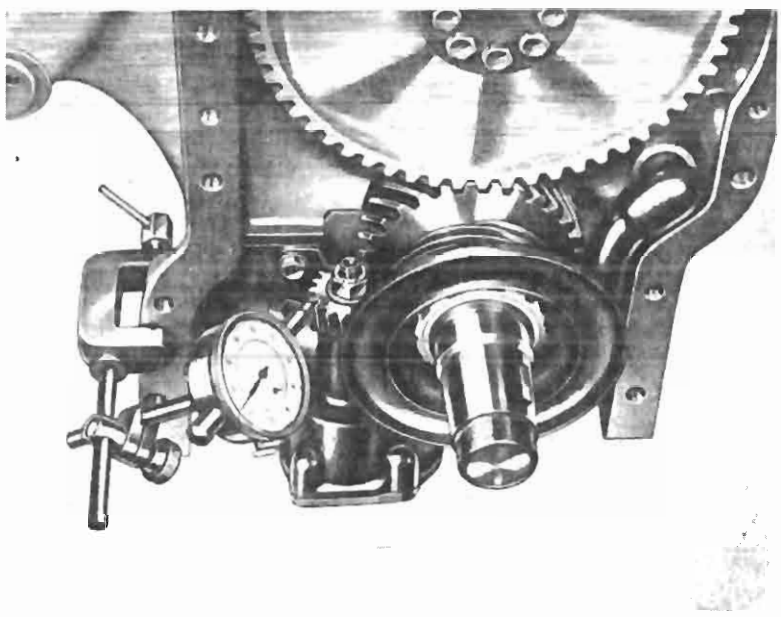

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Fig. E24 Checking backlash of oil pump drive

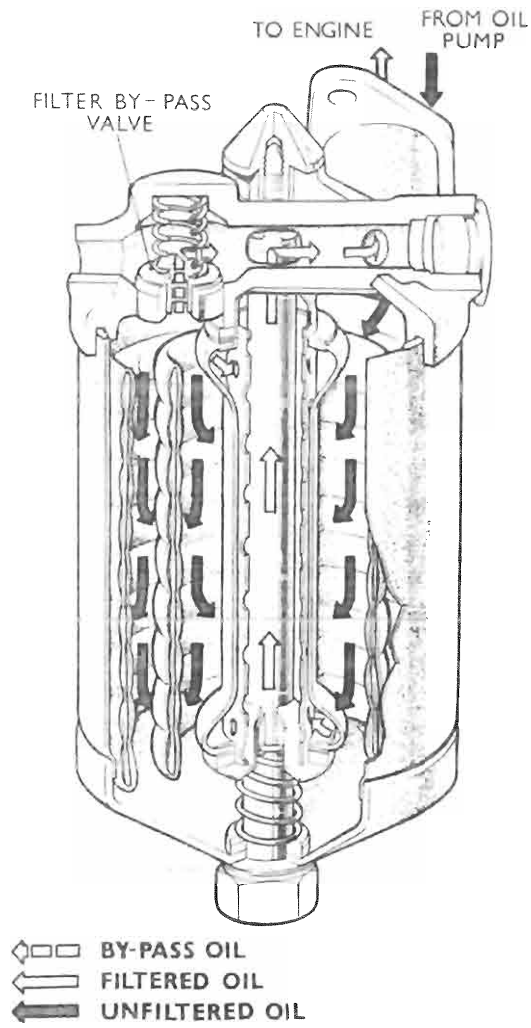


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**Fig. E25 Cut-away view of oil filter**

### Oil filter

The 'British' Full-Flow oil filter is located at the lower front end of the crankcase on the 'B' bank side of the engine and is held in position by two setscrews and washers (see Fig. E25).

The filter consists of a felt element carried in a bowl beneath the filter head. The bowl locates in a groove in the outer lip of the head, sealing being provided by a rubber 'O' ring. Incorporated in the head of the filter is a relief valve which is designed to allow the oil to by-pass the filter should the felt element become clogged and cause a restriction of the oil flow. The relief valve is designed to operate when the pressure differential across the inlet and outlet of the filter reaches 10 lb./sq. in. approximately.

#### To change the oil filter element

The felt element of the filter should be renewed every 5,000 miles

To change the element it is recommended that the car is placed on a ramp and that the following procedure is followed.

Hold the bowl of the filter with one hand and unscrew the retaining bolt (see Fig. E26).

Remove the bowl and retaining bolt.

**Note:** On left-hand drive cars, the filter bowl can only be removed when the steering mechanism is on full left-hand lock.

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1 RETAINING BOLT

**Fig. E26 Oil filter**

Remove the rubber 'O' ring from the filter head.

Drain the oil from the filter bowl and remove the element.

Remove the conical cork washer, the spring and the rubber washer from the inside of the bowl and withdraw the retaining bolt and the Dowty seal.

Thoroughly wash the bowl in clean paraffin and wipe it dry with a clean cloth, ensuring that the rim and the bottom of the bowl are free from any foreign matter.

Inspect the Dowty seal, the conical cork washer and the rubber sealing washer for signs of deterioration or damage, and renew them if necessary.

Fit a new element, together with the retaining bolt, sealing washers and spring in the filter bowl The element should be installed over the retaining bolt so that the drilled centre piece is to the top. The recessed portion of the lower sleeve seats against the spring-loaded cork washer.

Ensure that the conical cork sealing washer and the cap washer are fitted correctly. Failure to fit either one or both of these washers will allow unfiltered oil to pass up the central tube of the filter and this can result in serious damage to the engine bearings.

Fill the filter bowl with a pint of clean oil and fit the bowl, together with a new rubber 'O' ring, to the filter head. Ensure that the corners of the element are not trapped between the bowl and the head; as a precaution to prevent this, it is permissible to turn the corners over. Check also that the bowl and the 'O' ring are seating correctly.

**To remove the filter head**

If it is necessary to remove the filter head from the crankcase, the bowl must first be removed as previously described. Then unscrew the two set-screws holding the head to the crankcase and remove the head and paper joint.

When refitting, a new joint must be used between the head and the crankcase. The filter bowl can be fitted only after the head is in position.

**Oil pressure transmitter — To fit**

To obtain an accurate oil pressure reading on S2 engines, it is essential that the oil pressure transmitter is correctly assembled to the oil filter head.

The transmitter should be fitted so that the raised portion of the cover is to the top of the filter and within 60° either side of the vertical datum.

The correct position of the transmitter can be obtained by fitting additional copper washers to the threaded union.

The part number of the copper washer is UD.8017.

When fitting the transmitter, a maximum of two washers can be used to obtain the correct position.

**The oil sump**

The sump is fabricated from pressed steel components and is fitted with baffle plates to prevent surging. Fitted to the sump are the dip-stick tube assembly and electric oil level gauge unit. Both have paper joints and if either part is removed a new joint should be fitted. The oil drain plug is provided with an aluminium sealing washer and if this plug is removed a new washer must be fitted.

# Section E7

## CYLINDER HEADS

**Description**

The two detachable cylinder heads of cast aluminium alloy are fitted with inlet and exhaust valve seat inserts of austenitic steel. The inlet valve guides are of cast iron and the exhaust valve guides of phosphor-bronze.

Carried on the top face of the head are the rocker shaft and the inlet and exhaust valve operating rockers.

The valves are in line in the head and have a seat angle of 45 deg.

Induction is through eight separate ports from the eight-branch induction manifold, and the exhaust system consists of two separate four-branch manifolds.

Compression ratio is 8.00:1.

**Cylinder heads — To remove (with the engine in the car)**

Before commencing to remove the cylinder heads it is necessary to remove various parts as follows:

Disconnect the leads from the battery terminals.

Evacuate the refrigeration system and disconnect the pipes from the compressor. (If refrigeration is fitted.)

Drain the cooling system.

Disconnect and remove the air silencer and hosing.

Remove the bonnet.

Disconnect the heater and demister pipes from the cylinder heads and the water pump.

Disconnect the top hose of the cooling system.

Remove the choke stove pipes.

Disconnect the exhaust pipes from the manifolds, then remove the exhaust manifolds and gaskets.

The electrical system for the engine is carried in a loom, clipped to the induction manifold. Disconnect the wires at the following points:

Coolant temperature indicator.

Generator terminals.

Automatic choke solenoid.

Ignition coil.

Disconnect the flexible fuel pipe from the union at the rear of 'A' bank cylinder head.

Disconnect the carburetter throttle linkage and the throttle valve control linkage.

Detach the rubber vacuum pipes from the induction manifold (coachbuilt cars only).

Disconnect the pipes from the power-assisted steering pump.

Slacken the bolts securing the generator and the power-assisted steering pump, then remove all the driving belts.

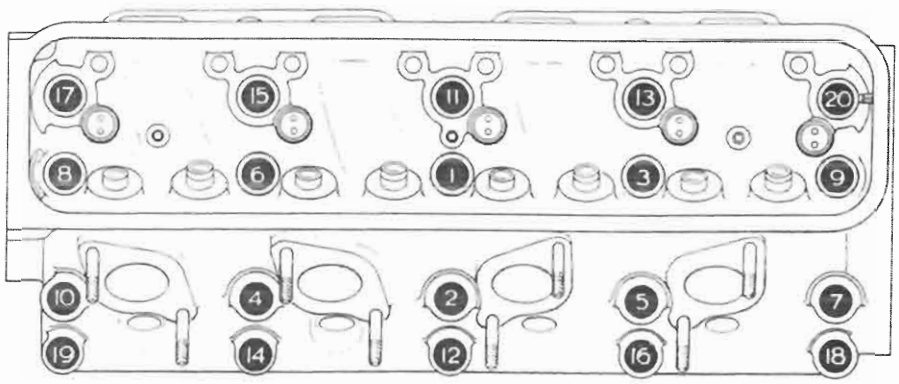


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**Fig. E27 Sequence of tightening cylinder head nuts**

Remove the refrigeration compressor (if fitted), together with its mounting bracket, from the 'A' bank cylinder head.

Remove the generator which is secured to the two-tier induction manifold and to an adjustable arm on the coolant pump.

Remove the power-assisted steering pump, then detach the oil filler assembly which is secured to 'B' bank cylinder head by means of three studs and nuts.

Disconnect the throttle linkage from the carburetters and remove the petrol feed pipes.

Remove the air horns, the butterfly housing, the carburetters and the 'T' piece as an assembly; the assembly is located on the induction manifold by two dowels and is secured by means of a single bolt which passes through the 'T' piece and screws into the manifold.

Disconnect the high tension (H.T.) lead from

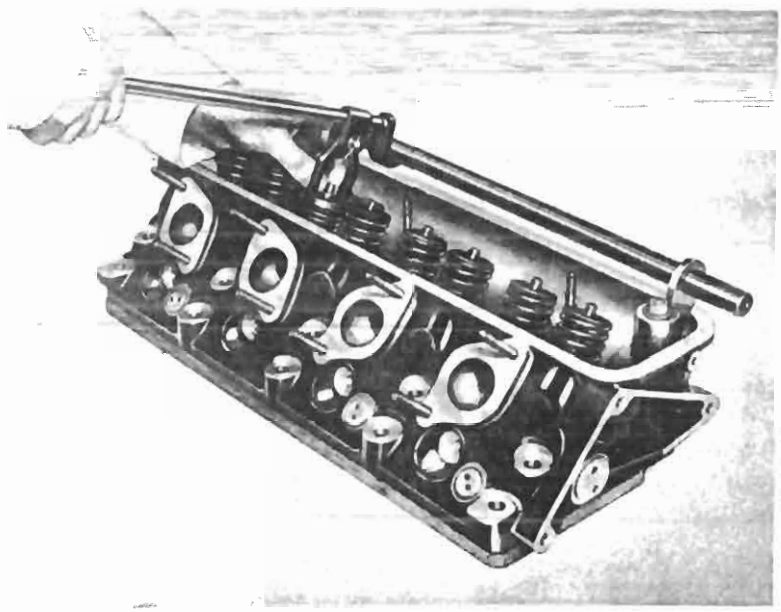

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**Fig. E28 Removal of valve collets**

the coil, then unscrew the 16 setscrews and remove the induction manifold.

Disconnect the sparking plug leads and remove the sparking plugs.

Remove the rocker covers and progressively unscrew the five setscrews securing the rocker pedestals to the cylinder head, and remove the rocker shaft assemblies; these assemblies consist of the rocker shaft, rockers, spacing springs and pedestals. Withdraw the push rods.

Using special tool RH.7126, progressively unscrew the cylinder head retaining nuts, commencing with those at each end and working inwards; each cylinder head is secured by 20 nuts arranged in four rows of five. Lift off the cylinder head.

**Cylinder heads — To fit**

When fitting the cylinder heads, reverse the procedure given for removal, noting the following points.

Coat both faces of the new cylinder head gaskets with 'Welseal', making sure that any excess jointing compound is removed when the gaskets are correctly positioned.

The side marked TOP should be uppermost otherwise two coolant holes will be blocked up and overheating will occur.

The heads must be tightened down progressively to the sequence shown in Fig. E27. The correct torque loading figure is 40 lb. ft.

**Valves — To remove (see Fig. E28)**

Special tool required, No. RH.7094.

Fit a valve tool pedestal at each end of the cylinder head. The pedestals locate in the recesses in the head for the rocker pedestals and are held in place by two nuts and bolts.

Place the head on the block of wood to prevent the valves from moving when the springs are compressed.

Insert the fulcrum bar through the holes in the pedestals.

Fit the hook of the valve spring compression tool under the rod and fit the stirrup over the valve top washers; compress the valve spring and remove the two collets, followed by the valve spring top washer, valve spring, bottom washer, gland housing, gland, and gland spring.

The cylinder head may then be turned over and the valves removed.

> **Note:** Each valve has a number etched on the stem of the valve adjacent to the collet groove; when refitting, the valves should be fitted to the guide corresponding to this number. The inlet and exhaust valves are numbered separately from 1 to 4 from the front of the engine and are preceded by either the prefix 'A' or 'B' to distinguish between the two cylinder heads.

**Valves — To fit**

Ensure that each valve is fitted to the guide from which it was removed. Should new valves be fitted it is advisable to mark the stem as stated above if an etching needle is available.

To fit the valves, reverse the procedure given for their removal. Care should be taken when fitting the collets to ensure that the bonded rubber tips are not damaged or trapped.

## Section E8

## VALVE GUIDES – TO RENEW

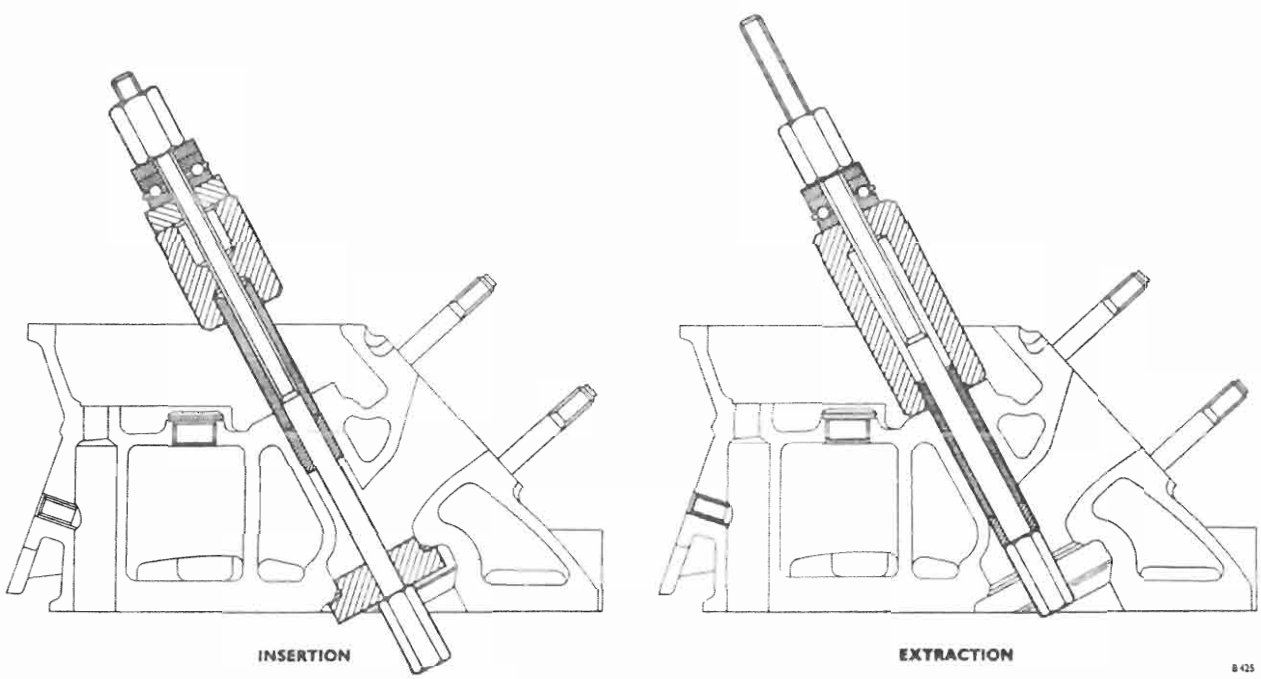



**Fig. E29 Valve guide renewal**

The modification to valve guides incorporating oil seal glands on late S2 engines has necessitated a modified guide block (RH.7272). A universal tool (RH.7207) has been designed for both inlet and exhaust valve guides, which replaces RH.7116/7.

**Valve guides – To remove**

The valve guides should be removed from the cylinder head, using special tool (RH.7207). Draw the guides out from the rocker side of the engine.

**Valve guides – To fit**

Clean out the valve guide bores in the cylinder heads and measure the diameters of the bores. Select a new set of oversize guides that will give the correct interference fit when fitted in the heads. The interference fit for both inlet and exhaust guides is 0.0015 in. to 0.003 in. Draw the valve guides into the cylinder heads from the rocker side, using special tools RH.7272 and RH.7207, as shown in Figure E29.

Fit both the inlet and exhaust valves, ensuring that the top faces are 0.450 in. –0.015 in. proud of the cylinder heads.

The insertion and extraction tools RH.7116/7 used on early S2 engines may still be used in conjunction with RH.7272.

Valve guide protrusion on early S2 engines was 0.850 in. –0.015 in. for the inlet guide, and 0.500 in. –0.015 in. for the exhaust guide.

When the guides have been fitted, the bores should be reamed to a finished size of 0.3755 in. +0.0005 in., using the special reamer tool RH.7120.

## Section E9

## VALVE SEAT INSERTS — TO RENEW

**Valve seat inserts — To remove**

The inserts should be removed from the head by machining. A thin skin of metal, 0.010 in. thick, should be left after machining; this can then be removed quite easily without damaging the insert bore in the head.

**Valve seat inserts — To fit**

Should it be necessary to fit new valve seat inserts it is recommended that the heads are returned to the Rolls-Royce Service Station at Pym's Lane, Crewe.

If the necessary facilities for fitting new inserts are available proceed as follows.

Check the size of the bore in the head from which the valve seat insert has been removed. The diameter of this should be 1.750 in. to 1.751 in. for the exhaust seat insert and 2.025 in. to 2.026 in. for the inlet seat insert.

If the bores do not conform to these sizes it will be necessary to machine them to a larger diameter and to fit an oversize seat insert. The insert should be an interference fit of 0.003 in. to 0.0045 in. for both inlet and exhaust.

To fit the seats it is necessary to heat the head in an oven at a temperature of 305 deg.F. (151.5 deg.C.) for a period of one hour. The head should then be quickly removed and the inserts driven into their bores in the head, using a suitable drift. Do not finish-machine the valve seats until after the valve guides have been reamed out.

# Section E10

## CRANKSHAFT AND MAIN BEARINGS

**Description (see Fig. E30)**

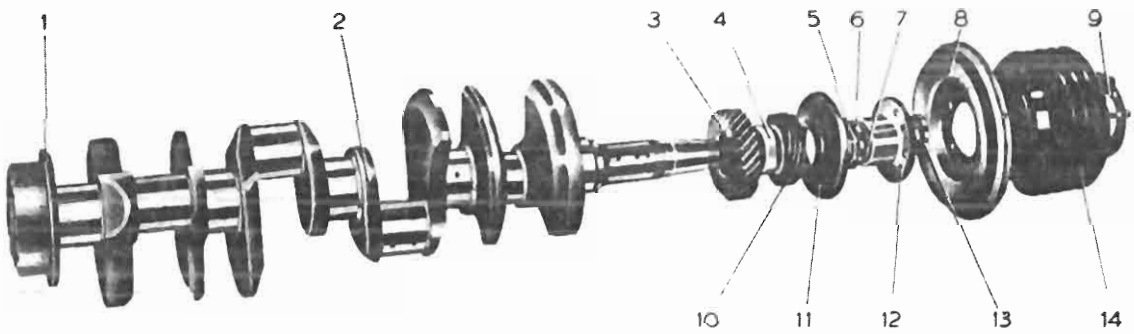
The crankshaft is a chrome molybdenum steel forging with integral balance weights. There are five main bearings running in split shell steel bearings copper-lead lined with either lead-tin or lead-indium overlay. Four journals carry the connecting rods, i.e. two connecting rods per journal.

End thrust on the shaft is taken by split washers on either side of the centre main bearing. These washers are coated with bronze on one face and should be fitted so that this face is on the outside of the main bearing. The lower halves of the washers, i.e. the halves which fit into the bearing caps, are keyed to the bearing cap to prevent them rotating. Both halves of the front end washers are marked with an 'X'.

The shaft is both statically and dynamically balanced before it is fitted to the engine and at a later stage, when the engine is part assembled, the crankshaft, connecting rods and pistons are again dynamically balanced.

In order to ensure that there is no oil leakage at the front or rear of the engine, oil flingers are fitted to the shaft. The rear flinger is pressed on to the end of the shaft and runs inside a recess on the rear end back plate. At the front end there are two flingers; these are held on to the shaft by a slotted nut. The flingers run inside two recesses machined in the lower front half casing.

**Note:** The crankshaft is not nitride hardened and great care should be taken to ensure that the journals are not damaged or scored.




| | | | |
|---|---|---|---|
| 1 | REAR OIL FLINGER | 8 | METALASTIK DAMPER |
| 2 | CRANKSHAFT | 9 | LOCKING PLATE |
| 3 | CRANKSHAFT DRIVING PINION | 10 | OIL PUMP DRIVING PINION |
| 4 | SPACER | 11 | OIL FLINGER |
| 5 | WASHER | 12 | PULLEY DRIVE FLANGE |
| 6 | SLOTTED NUT | 13 | SLOTTED NUT |
| 7 | 'O' RING | 14 | DRIVING PULLEY |

**Fig. E30** Exploded view of crankshaft

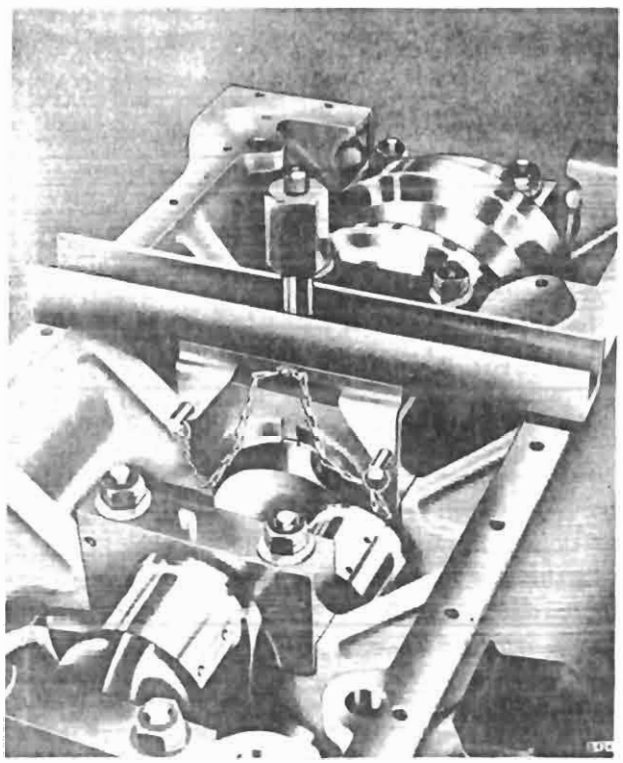


Fig. E31 Removal of main bearing cap

### Crankshaft — To remove

To remove the crankshaft from the engine, it is necessary to remove the engine and gearbox from the chassis frame following the procedure described in Section E4.

Having done this, the unit should be placed in a suitable 'turnover stand' and the gearbox removed. To do this, it will be necessary to remove from the bell housing, the crankcase oil breather pipe and the carburetter petrol drain pipes, also to disconnect the throttle valve linkage from the gearbox to throttle linkage.

Remove the starter motor.

Remove the dipstick and its holder from the sump and remove the sump. The oil pedestal and strainer may then be removed from the bottom face of the crankcase.

Remove the flywheel and the engine back plate; this plate is dowelled to the crankcase.

Slacken off and then remove the belts driving the generator and power-assisted steering pump. Remove the generator and coolant pump from the engine

Remove the crankshaft pulley and Metalastik damper from the front end of the crankshaft, then, using the special withdrawal tool (No. RH.7097), remove the pulley driving flange. Remove the lower front half casing; this is dowelled to the crankcase.

It will then be possible to remove the oil pump and the delivery pipe to the oil filter. It is not necessary to remove the camshaft timing wheel, but to ensure against possible damage to the wheel, it is strongly recommended that it be removed

Unscrew the nuts from the connecting rod bolts, remove the connecting rod caps and the shell bearings from both the caps and the rods. Fit rubber tubing over the connecting rod bolts to prevent damage to the shaft, and then push the pistons to the top of their bores.

Remove the main bearing caps and bearings, using the special extractor tool (RH.7208) (see Fig. E31). Remove the thrust washers from the centre main bearing. Fit rubber tubing over the main bearing cap studs to prevent damage to the crankshaft. The crankshaft may now be removed from the crankcase.

Great care should be taken to ensure that the journals and crankpins are not damaged by the studs when removing the shaft.

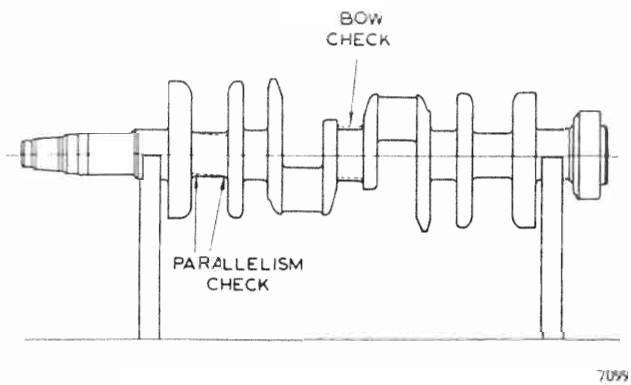



Fig. E32 Crankshaft bow and parallelism

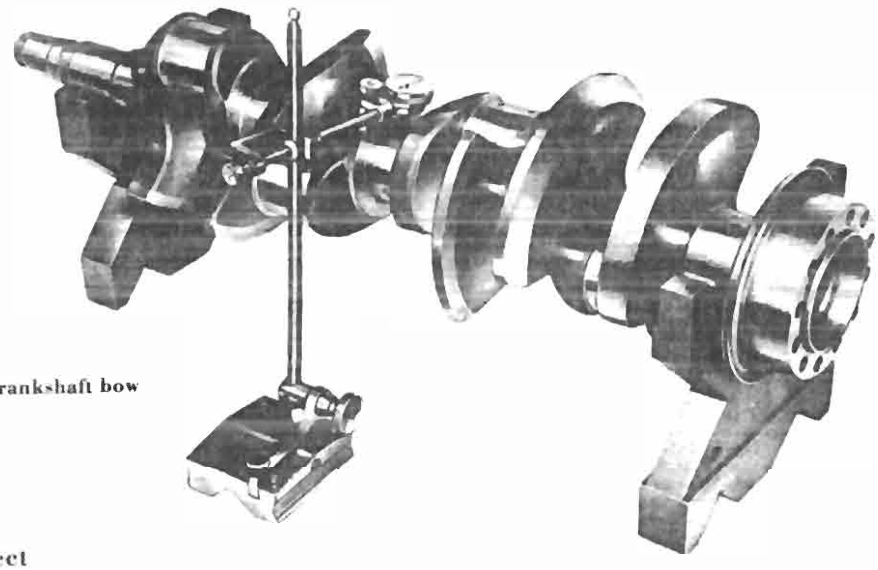


Fig. E33 Checking crankshaft bow

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**Crankshaft — To inspect**

Place the crankshaft on a suitable stand or fixture and check the crankpins and journals for wear with a micrometer (parallelism and ovality) (see Fig. E32).

With a pair of Vee-blocks on a marking-out table, set up a parallel test bar in the blocks. Using a dial indicator gauge, check that the bar is parallel to the table. This will ensure that the axis of the crankshaft, when placed in the blocks, is parallel to the table, providing there is no wear on the journals. If there is wear on the journals, set up the shaft in the blocks on No. 1 and 5 journals and, allowing for the wear, pack up the Vee-blocks until the shaft is parallel with the table. The dial indicator gauge will again be required to check the crankpins and journals for parallelism at various points on their circumference.

Rotate the crankshaft in the Vee-blocks and make a check on the centre journal for bowing, using the dial indicator gauge. The actual bowing will be half the maximum reading on the gauge and when ascertaining this figure any ovality on the journal should be taken into account. The maximum permissible bow is 0.010 in. If this figure is exceeded, the crankshaft must be reground.

**Crankshaft — To regrind**

If the crankshaft is worn it will be necessary to regrind it to restore the journals and crankpins to true diameters.

The minimum permissible diameter for the crankshaft journal is 2.4985 in. and for the crankpin 2.2475 in.

Undersize bearings are supplied in multiples of 0.010 in. from standard size to a maximum of 0.040 in. undersize.

Standard and undersize diameters of the crankshaft journals and pins together with their corresponding bearings are as follows:

| | Crankshaft Journal | Main Shell Bearing |
|---|---|---|
| Standard | 2.500 in.—0.0005 in. | 2.501 in. +0.001 in. |
| 0.010 in undersize | 2.490 in.—0.0005 in. | 2.491 in. +0.001 in. |
| 0.020 in. undersize | 2.480 in.—0.0005 in. | 2.481 in. +0.001 in. |
| 0.030 in. undersize | 2.470 in.—0.0005 in. | 2.471 in. +0.001 in. |
| 0.040 in. undersize | 2.460 in.—0.0005 in. | 2.461 in. +0.001 in. |

*ACTUAL* RUNNING CLEARANCE 0.0015 in. to 0.0035 in.
MAXIMUM PERMISSIBLE CLEARANCE 0.0045 in.

| | Crankpin | Big-end Bearing |
|---|---|---|
| Standard | 2.249 in.—0.0005 in., | 2.2505 in. +0.001 in. |
| 0.010 in. undersize | 2.239 in.—0.0005 in. | 2.2405 in. +0.001 in. |
| 0.020 in. undersize | 2.229 in.—0.0005 in. | 2.2305 in. +0.001 in. |
| 0.030 in. undersize | 2.219 in.—0.0005 in. | 2.2205 in. +0.001 in. |
| 0.040 in. undersize | 2.209 in.—0.0005 in. | 2.2105 in. +0.001 in. |

RUNNING CLEARANCE 0.0015 in. to 0.003 in.
MAXIMUM PERMISSIBLE CLEARANCE 0.0035 in.

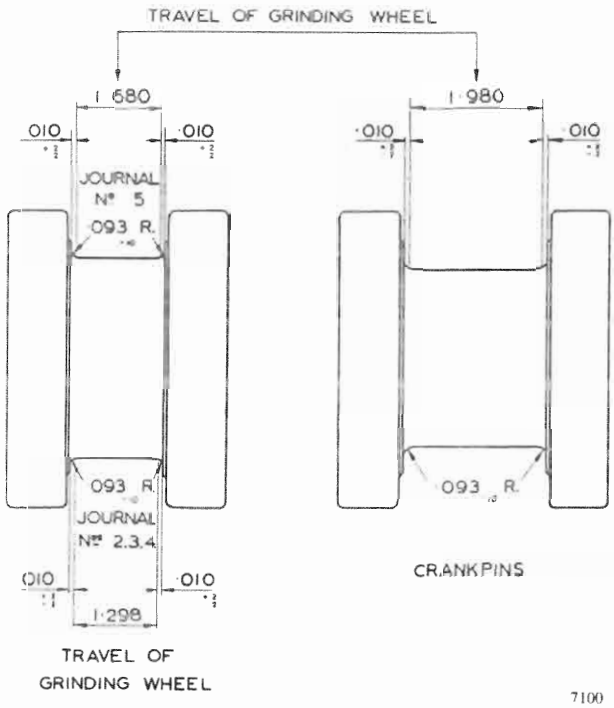


Fig. E34 Crankpin and journal grinding dimensions

When undersize bearings are fitted, the size of the bearing should be etched on the outside of the shell.

Set up the shaft on the grinding machine; when grinding the crankpins it is necessary to run the shaft eccentrically by using special adaptors and centring plugs.

Whilst grinding the shaft a liberal amount of grinding lubricant should be applied to prevent cracking.

On no account must the grinding wheel touch the side-radii of the crank-webs. Stops must be arranged on the grinding machine to limit the travel of the wheel to 0.010 in. from each web (see Fig. E34). The radius of the grinding wheel should be maintained so that the grinding fades out not more than halfway round the radii.

Finish grind the crankshaft to 0.0002 in. above the final diameter for both the journals and the crankpins

When grinding of the journals and crankpins is completed, the crankshaft should be tested magnetically for any grinding cracks.

Wash the crankshaft thoroughly in a high-pressure paraffin wash; blow off any surplus paraffin with compressed air and dry the shaft with a soft lint-free cloth.

Set up the crankshaft in a lapping machine or lathe and hand polish the journals and crankpins to the final diameters. Polish the shaft by using Corolite abrasive strip 1 in. wide.

After polishing, again wash the shaft and repeat the procedure of cleaning.

**Crankshaft — To fit**

When the reconditioned crankshaft has been thoroughly inspected it should be refitted in the

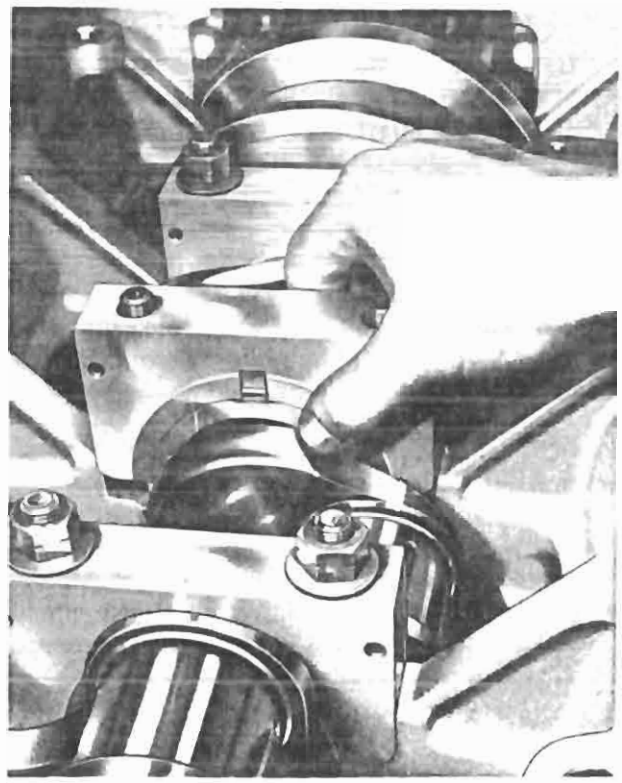


Fig. E35 Fitting centre main bearing cap

manner described below, particular care being taken over the two following points:

(1) Ensure that the bearing shells are the correct size for the crankpins and journals.

(2) Ensure that all parts are clean. A lint-free cloth should be used for wiping all parts.

Fit rubber tubing over the connecting rod bolts and main bearing cap studs to prevent the possibility of damage to the crankpins and journals.

Position the upper bearing shells in the crankcase and lightly smear them with engine oil.

Place the crankshaft in position and fit the upper halves of the thrust washers to the centre main bearing.

Fit the main bearing caps and shells, together with the two lower thrust washers for the centre main bearing (see Fig. E35). When fitting the bearing caps it may be necessary to tap them lightly 'home'. If this is done, ensure that the bearing shells are not dislodged. The cap nuts should be tightened to a torque loading of 45 lb. ft.

Check that the crankshaft rotates freely.

Check the crankshaft end float (see Engine Data and Fig. E36).

Fit the bearing shells to the connecting rods and caps, then lightly smear the shells with oil. Fit the caps to the rods and tighten the nuts to a torque loading of 32 lb. ft. to give a bolt stretch of 0.005 in. (see Fig. E39)

Fit the camshaft timing wheel, resetting the valve timing as described in Section E13.

Fit the oil pump and delivery pipe, using new rubber 'O' rings for sealing the delivery pipe. Fit the oil strainer pick-up and pedestal (see Fig. E37).

Connect a pressurized supply of clean oil to the oil supply hole in the crankcase and pump oil into the crankcase at a pressure of 80 lb./ sq. in. Check the oil flow to the main and big-end bearings. Prime the oil pump by filling the strainer with clean oil and, at the same time, turning the crankshaft

Assemble the front end of the engine, fitting the lower front half, the damper, the driving pulley, the coolant pump, the generator and the belts. A new Neoprene seal must be fitted between the lower front half and the coolant pump.

Fit the engine backplate and flywheel.

Fit the sump, using a new paper joint, followed by the dipstick holder and the dipstick.

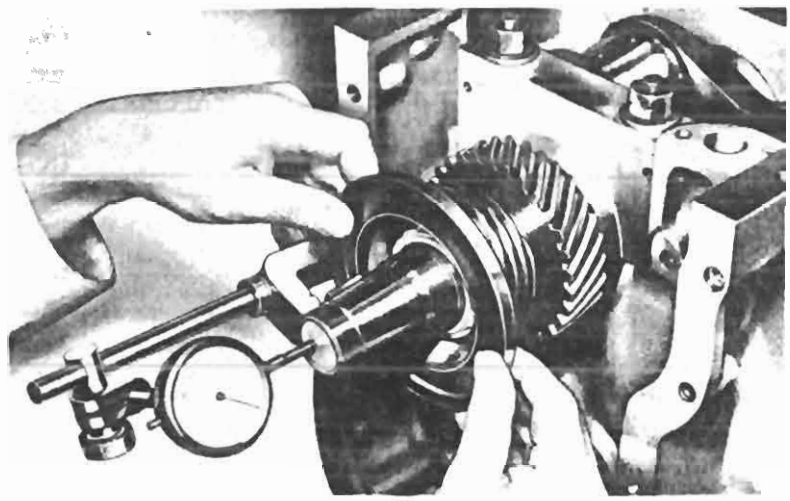

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**Fig. E36 Checking crankshaft end float**

New paper joints should be fitted where necessary and the backlash and end float on the crankshaft, camshaft and oil pump gears should be checked.

**Main bearings**

Shell bearings, removed from an engine during maintenance or overhaul, must always be refitted in their original positions. On initial assembly, each pair of shell bearings are marked with their appropriate position in the crankcase. They are not, however, marked top and bottom and care should be taken that they are not interchanged. When refitting the shells check that the locating tangs are registering correctly in their recesses.

**Main bearings — To remove without removing the crankshaft**

It is possible to remove both the upper and lower halves of the shell bearings from the crankcase while the crankshaft is still in position in the engine, but it is not possible to check the journals for wear.

The following procedure is recommended for their removal:

Remove the undersheets from the chassis frame.

Drain the oil from the sump.

Disconnect the down-take pipe from the 'A' bank exhaust manifold and from the main exhaust pipe beneath the chassis frame. Both ends of the pipe are held by three nuts and bolts; a triangular steel gasket being fitted between the faces. Before removing the down-take pipe, the bracket holding the pipe to the engine mounting cross-piece must also be removed.

Unscrew the nuts from the two bolts, securing the right-hand side of the engine mounting cross-piece to the chassis frame, and place the right-hand jack of the special engine jacking tool (No. RH.7111) over the two bolts. Refit the nuts holding the jack in position. Repeat this operation for the other side of the frame, using the left-hand jack.

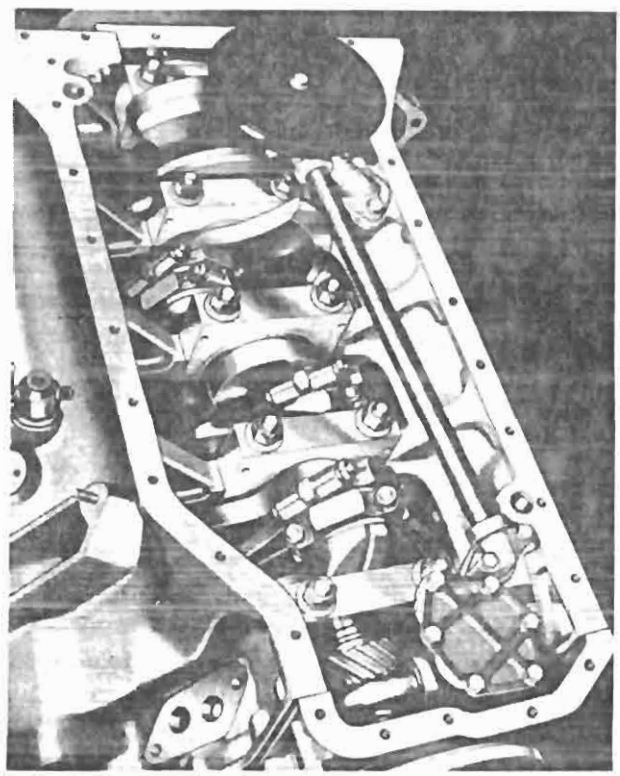

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**Fig. E37** View of main bearing caps, etc.

Wind the two jacks up until they come to bear on the mounting brackets fitted on each side of the crankcase. Continue winding until the jacks just take the weight of the engine off the rubber suspension block, then remove the engine mounting 'U' piece and the rubber suspension block from the crankcase and the cross-piece.

The engine may then be lifted by the jacks until the sump is well clear of the engine mounting cross-piece.

Unscrew the setscrews securing the sump in position and remove the sump.

Remove the oil pedestal and fine-mesh strainer.

Remove the sparking plugs; this will facilitate rotation of the crankshaft which can be done by hand when the flywheel timing cover has been removed.

Remove the cap of the bearing which is to be renewed, using the special main bearing cap extractor tool (RH.7208). Care should be taken when removing the bearing cap that the cap and extractor do not fall.

Do not remove more than one bearing cap at a time

Slide out the top half of the bearing in an anti-clockwise direction around the crankshaft. To assist in the removal of the bearing, the crankshaft should be rotated at the same time.

> **Note:** If it is necessary to remove the front main bearing cap, first remove the track rods and move the centre steering lever and idler lever to one side.

The thrust washers may be removed from the centre main bearing in a similar manner to that described above.

**Main bearings — To inspect**

On removal, the main bearings should be thoroughly washed in clean paraffin and then wiped dry with a lint-free cloth before they are inspected.

Inspect the bearings visually and scrap any that are obviously damaged, i.e. scored, ridged, or showing excessive wear of the lead indium lining.

Select new bearings of the correct size to replace the rejected shells. Undersize bearings are supplied in multiples of 0.010 in. to 0.040 in. The size is marked on the back of the bearing.

*Do not file, scrape or shim any of the bearing shells or caps to obtain a good fit.*

**Main bearings — To fit**

Fit the top half of the bearing to the crankcase, after first lightly smearing it with oil. It should be fitted by sliding it round the crankshaft in a clockwise direction. For approximately the last half-inch, the bearing shell may be tapped gently into position with a thin piece of hardwood until the tang on the bearing shell is fully registered in the locating slot. Extreme care should be taken at this stage to avoid any damage to the journal.

Do not attempt to press the locating tang into the slot by drawing up the bearing cap on its studs.

Fit the bearing shell to the cap and smear lightly with oil. Fit the bearing cap and shell to the crankcase and if necessary gently tap them into position, using a hide mallet. Before finally tapping the cap 'home' ensure that the bearing shell has not been dislodged. Finally tighten the main bearing capnuts to a torque loading of 45 lb. ft.

When all the bearings have been changed and the caps have been tightened down, the crankshaft should rotate freely when turned by hand.

Fit the oil pedestal and fine-mesh strainer.

Refit the sump, using a new paper joint.

Fit the engine mounting 'U' piece and rubber suspension block to the crankcase. Lower the engine by the jacks until the suspension block is resting on the mounting cross-piece. Fasten the block to the cross-piece, then remove the lifting jacks from the chassis frame. The jacks should be removed one at a time.

Refit the exhaust down-take pipe to the 'A' bank manifold and the main exhaust system, using new steel gaskets. Fasten the pipe to the bracket on the front engine mounting.

Refit the steering track rods if they have been removed.

Fit the undersheets to the chassis.

Fit the sparking plugs.

Refill the engine with clean oil.

## Section E11

## CONNECTING RODS AND PISTONS

**Description (see Fig. E38)**

The connecting rods are 'forged to size' from either chrome molybdenum or low nickel chrome molybdenum steel and are of 'H' shape cross section. They are accurately balanced, before fitting to the engine, by machining the excess weights from the balance pad on the large end and from the boss on the small end.

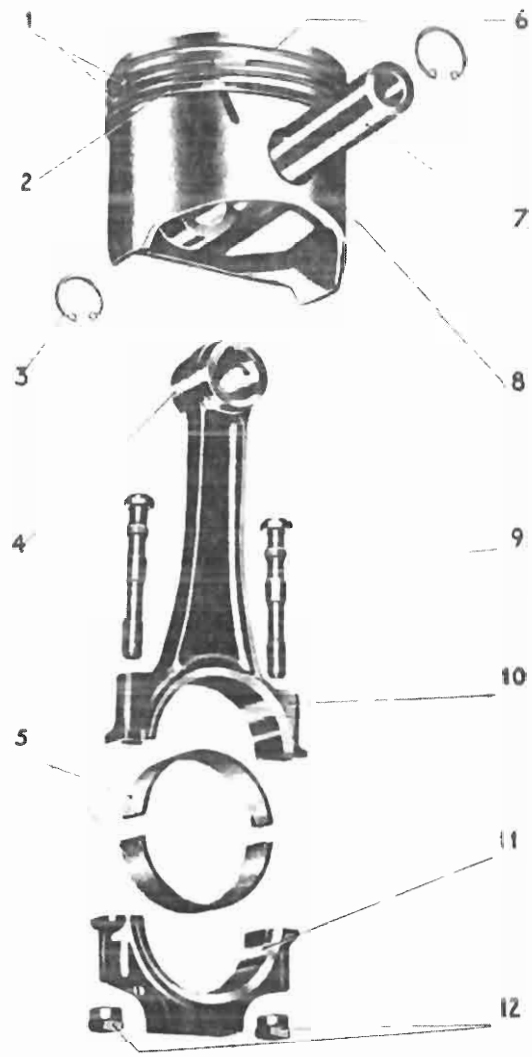
Drillings in the crankshaft webs, from the main bearings to the big-end journals, carry oil for the lubrication of the big-end bearings. Oil splash and mist collecting under the crown of the piston falls on to the connecting rod small-end boss and then passes through a recessed drilling in the boss to provide lubrication for the gudgeon pin and small-end bush.

The big-end bearings are detachable and are split steel shells copper-lead lined with either lead-tin or lead-indium overlay. The small-end bush is split and has a steel backing lined with lead bronze. The bush is pressed into the small-end boss and then reamed out to a final diameter of 0.8753 in. +0.0002 in.

The weight of the connecting rod and piston assembly is 3 lb. 15 oz. Side float of the rod is controlled at the bottom end by the clearance between the connecting rods and the crankpin end faces and should be between 0.008 in. and 0.017 in.

The pistons are of an aluminium alloy, having full skirts and recessed crowns, which give a compression ratio of 8 : 1. The skirts are cam ground to permit a close fit between the piston and the cylinder liner and after grinding they are tin coated to reduce friction between the bearing surfaces.

*The top compression ring* is chromium plated to a depth of 0.004 in. to 0.006 in. and both the outer and inner edges are chamfered. This prevents the ring from sticking in the groove.




1 LOWER COMPRESSION RINGS
2 SCRAPER RING
3 CIRCLIP
4 CONNECTING ROD SMALL END
5 CONNECTING ROD BEARING
6 TOP COMPRESSION RING
7 GUDGEON PIN
8 PISTON
9 CONNECTING ROD BOLTS
10 CONNECTING ROD
11 CONNECTING ROD AND CAP
12 NUTS

**Fig. E38 Exploded view of piston and connecting rods**

Both the lower compression rings are finished formed with a taper of 1° to 1½° towards the upper face on the outer edges. These rings are clearly marked TOP on the upper face and must be fitted in the correct way, i.e. with the faced marked TOP towards the crown of the piston. The inner edges of these two rings also have a chamfer of 0.010 in. at 45° to prevent the rings from binding or sticking in the piston grooves.

The bottom ring is an oil scraper ring assembly, consisting of an expander, a spacer and two steel rails. The expander is nonagonal in shape and is fabricated in spring steel. It cushions the spacer and steel rails against the cylinder wall. The upper and lower steel rails are, in turn, located by the spacer.

The piston is carried on the connecting rod by a gudgeon pin. The pin is fully floating when the engine is running under normal conditions and end location of the pin is provided by two Seegar circlips. The case hardening of the gudgeon pin is 0.020 in. to 0.030 in. deep.

**Connecting rod bearings — To remove**

The big-end bearings may be replaced whilst the engine is still in position in the car. To do this, however, various parts must be removed from the chassis.

The following procedure is recommended for their removal:

Remove the sump with the aid of the special engine jacking tool (No. RH.7111), as described in Section E10.

Remove the oil pedestal and fine-mesh strainer.

Remove the sparking plugs; this will facilitate rotation of the crankshaft which can be done manually when the flywheel timing cover has been removed.

Rotate the crankshaft until one pair of connecting rod caps are at the bottom of their stroke, and then remove the nuts from the connecting rod bolts. Ease off the caps and the bearing shells, then fit rubber tubing over the connecting rod bolts to prevent damage to the crankshaft. Push the pistons up the bores until the connecting rod bolts are clear of the crankpins, and remove the bearing shells from the rods.

Rotate the engine until another pair of rods are on bottom dead centre and repeat the above operation. In doing this, ensure that the bolts securing the caps, previously removed, do not foul the crankshaft when it is being rotated.

Do not remove the connecting rod bolts.

**Crankpins and bearings — To inspect**

Thoroughly clean the crankpin with a lint-free cloth, then measure the crankpin diameter, checking for wear and ovality with a micrometer.

The diameter of the journal crankpin is 2.2485 in. to 2.2490 in. when new and the worn dimension must not be below 2.2475 in.

The running clearance between the connecting rod big-end bearing and the crankpin journal is 0.0015 in. to 0.003 in., measured in the plane of the rod centre line. The maximum permissible wear should not exceed 0.0035 in.

Bearing shells on which the lead indium lining has worn through should be replaced.

The 'draw' between the bore of the rod and the outer diameter of the bearing shells, i.e. the amount by which the bearing shell is larger than the connecting rod bore, should be 0.0015 in. to 0.003 in. This 'draw', or nip, is necessary to ensure that the bearing shells are firmly located in the connecting rod and cap, and this prevents the bearing shell from rocking or fretting in the rod.

**Connecting rod bearings — To fit**

The upper and lower bearing shells are interchangeable, but it is recommended that if they are refitted they should be fitted as they were before removal.

Before fitting new bearings to the connecting rod and cap, etch the number of the bore on the small locating tang. Then thoroughly clean the shells and the crankpin, checking that there is no

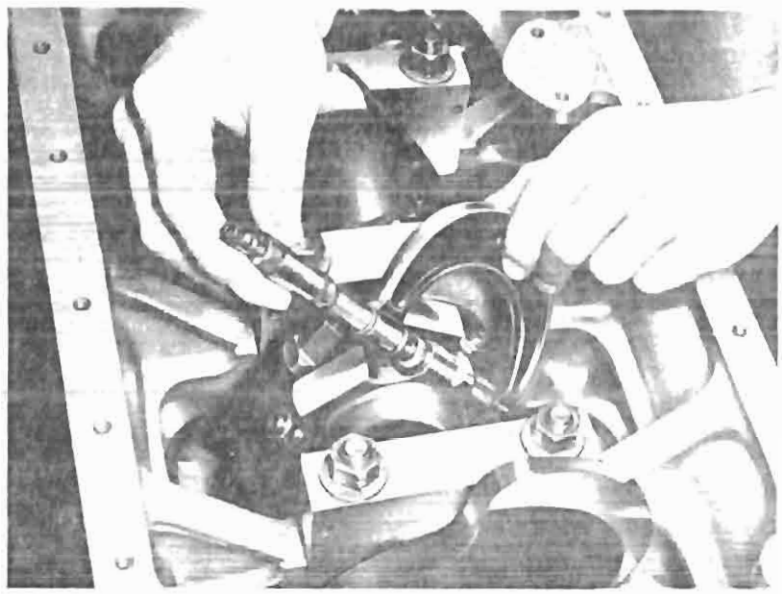


Fig. E39 Checking stretch of connecting rod bolt

sludge or dirt in the feed holes from the main bearings. Lightly smear the bearing with oil and fit it into the connecting rod. Remove the rubbers and pull the rod down on to the crankpin, again ensuring that the bolts do not mark or score the crankpin. Fit the second shell into the connecting rod cap and lightly smear it with oil. Place the cap on the rod, checking that it is fitted the correct way round, i.e. the two tangs should both be on the same side of the crankpin. The cap will require a certain amount of gentle tapping before it is finally 'home'. Fit the nuts to the bolts and tighten them with a torque spanner. The bolts should be tightened to give a stretch of 0.005 in. which is approximately equivalent to a torque loading of 32 lb. ft. (see Fig. E39).

The connecting rod bolts have an interference fit in the rods and they should not be removed unless absolutely necessary.

Fit the remaining bearings in the same way, taking care that when the crankshaft is rotated the connecting rod bolts do not damage the crankpins.

Fit the oil strainer and pedestal.

Fit the sump, using a new joint.

Fit the sparking plugs.

**Connecting rods and pistons — To remove**

The piston and connecting rod assembly can only be removed from the engine at the top face of the crankcase, therefore it is necessary to remove the cylinder heads. The procedure for this is described in Section E7. The big-end bearings and connecting rod caps should also be removed in the manner previously described in this section. The pistons may then be withdrawn from the engine crankcase.

**Connecting rod and piston assembly — To dismantle**

To remove the gudgeon pins, first remove the circlip from each end of the piston, then immerse the piston in hot oil. The gudgeon pin is a 0.0002 in. interference fit in the piston at N.T.P. and the resultant expansion from immersing the piston in hot oil permits the pin to be removed freely.

**Pistons and cylinder bores — To inspect**

Thoroughly clean the cylinder bores, and then check the diameters, using a suitable dial indicator gauge (see Fig. E40). If the cylinders are worn more than 0.004 in. or their ovality exceeds 0.003 in., it is necessary to fit new liners and pistons. On no account should new pistons be

fitted to cylinders whose dimensions exceed the limits for wear and ovality.

Remove the piston rings with a suitable piston ring expander tool. Clean the carbon from the rings, the grooves and the pistons. Then check the clearance of the rings in the grooves. (Dimensions for this are given in the engine data). The compression rings, when fitted to a 4.100 in. diameter gauge, should show no light around the circumference. The closed gap can also be measured whilst the ring is fitted to this gauge and should read 0.015 in. to 0.020 in. The free gap should be 0.520 in. nominal.

Check the dimensions of the pistons across the thrust axis. The measurements should be taken at the piston grading point which is 0.906 in. above the bottom of the skirt

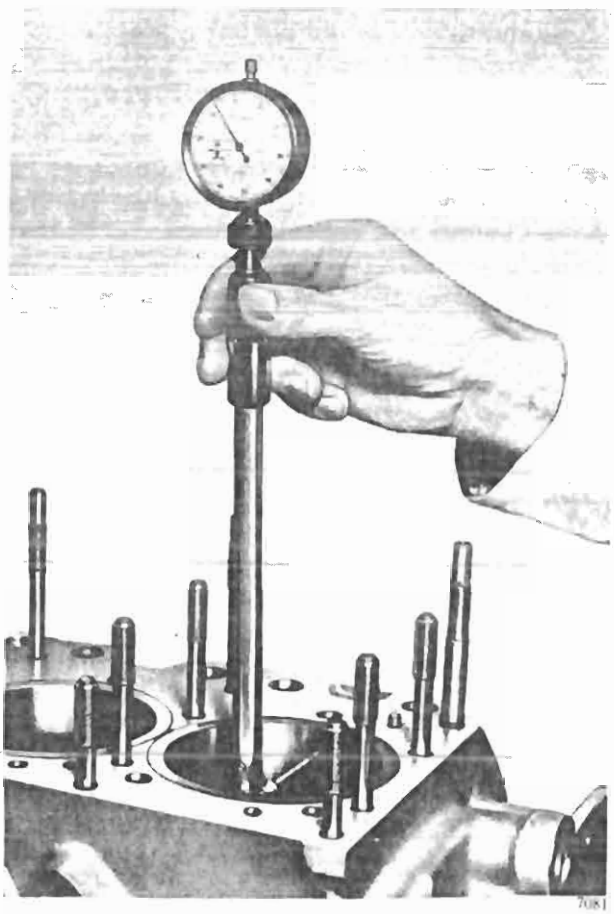


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**Fig. E40 Checking diameter of cylinder bore**

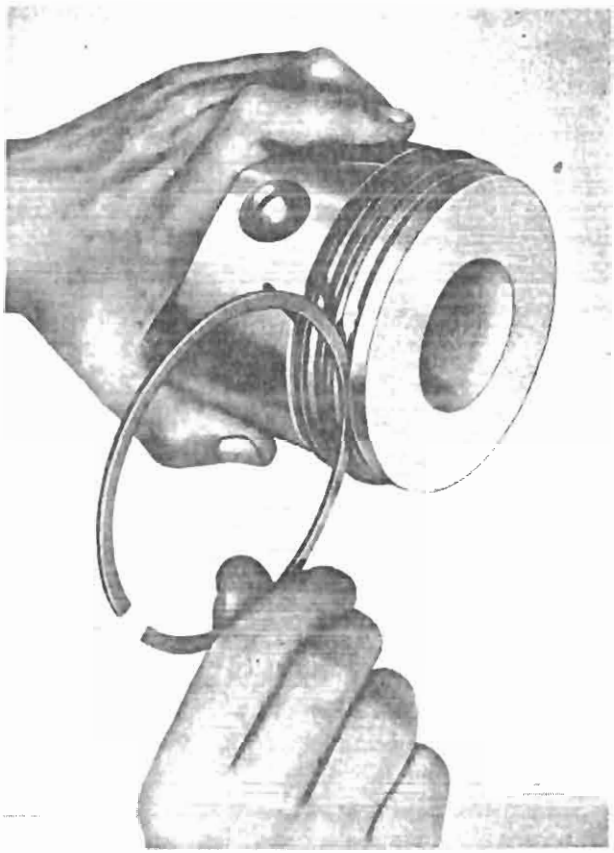

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**Fig. 41 Checking piston ring clearance**

The grading, the weight of the piston and the part number are all stamped on the piston crown.

The pistons are graded in five sizes as follows:

| Grading Letter | Grading Diameter |
|---|---|
| H | 4.0985 in. — 4.0988 in |
| J | 4.0989 in. — 4.0992 in |
| K | 4.0993 in. — 4.0996 in |
| L | 4.0997 in. — 4.1000 in |
| M | 4.1001 in. — 4.1004 in |

**Small-end bush — To renew**

Check the diameters of the gudgeon pin and the small-end bush and if the total clearance exceeds 0.0005 in. renew the bush.

Remove the small-end bush, using a suitable drift. Before fitting the new bush, check that the interference between the bush and the connecting rod is between 0.002 in. and 0.0035 in.

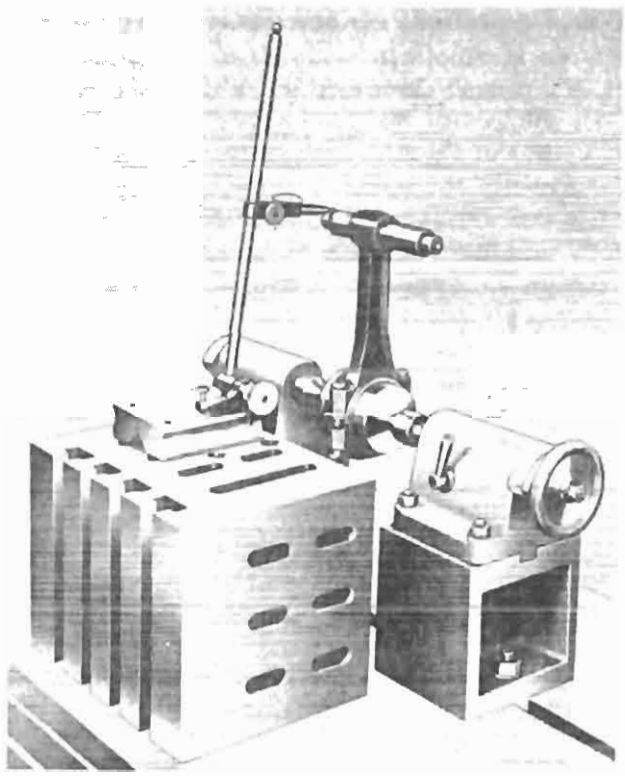

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Fig. E42 Checking connecting rod alignment

Press the bush into the connecting rod, ensuring that the split in the bush is positioned so that it is at 45° away from the central axis of the rod and on the same side of the rod as the locating recess for the big-end bearing shell. In this position the oil hole in the bush should line up with the oil hole through the small-end boss.

When fitted the bush should be diamond bored or reamed to a finished diameter of 0.8753 in. + 0.0002 in

The gudgeon pin fit in the small-end bush should be from a size fit to 0.0004 in. clearance.

**Connecting rods — To check alignment and twist**

The correct alignment of the connecting rods is of the utmost importance and all connecting rods, after rebushing and boring, should be checked for alignment in a reliable alignment indicator.

Connecting rods that are bent will produce slight knocking noises when under acceleration or loading and will also cause uneven and premature wear between the cylinder walls and pistons.

The alignment of the rods may be checked in the following manner if a suitable aligning fixture is not available.

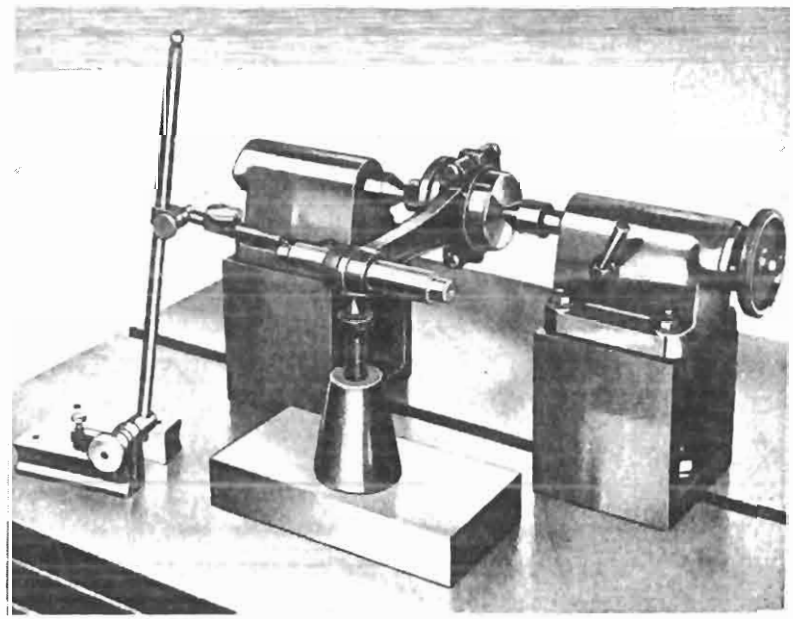

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Fig. E43 Checking connecting rod for twist

Fit the gudgeon pin to the small-end of the rod and a mandrel in the large end, then set up the connecting rod on a surface block, with the mandrel resting in Vee-blocks and with the rod in a vertical plane (see Fig. E42). Using a dial indicator gauge, take readings at both ends of the gudgeon pin. The difference between the two readings must not exceed more than 0.001 in. per inch length of the gudgeon pin.

Check the connecting rod for 'twist' in a similar manner to that for the alignment check, by setting up the rod with its axis parallel to the surface table (see Fig. E43).

The difference in the readings at each end of the gudgeon pin should not exceed 0.003 in. per inch length of the gudgeon pin.

Connecting rods can be corrected when the inaccuracies are small, but where greater errors exist new connecting rods must be fitted.

**Connecting rods and pistons — To reassemble**

Warm the piston in an oil bath or on a hotplate; this facilitates the fitting of the gudgeon pin. Hold the connecting rod in position inside the piston and fit a guide through the piston and the small end of the connecting rod. Using a hide mallet and with the aid of the guide, tap the gudgeon pin into position in the piston and connecting rod. Fit the circlips to either end of the gudgeon pin, thus securing it in the piston.

Pistons and gudgeon pins are supplied as an assembly, the gudgeon pin being supplied as a selective fit. On no account must pistons and gudgeon pins be interchanged.

When refitting the rings to the piston, first fit the scraper ring assembly. The scraper ring consists of two thin rails, an expander ring and a spacing ring. Fit the expander ring first, then the bottom steel rail, followed by the spacer and the

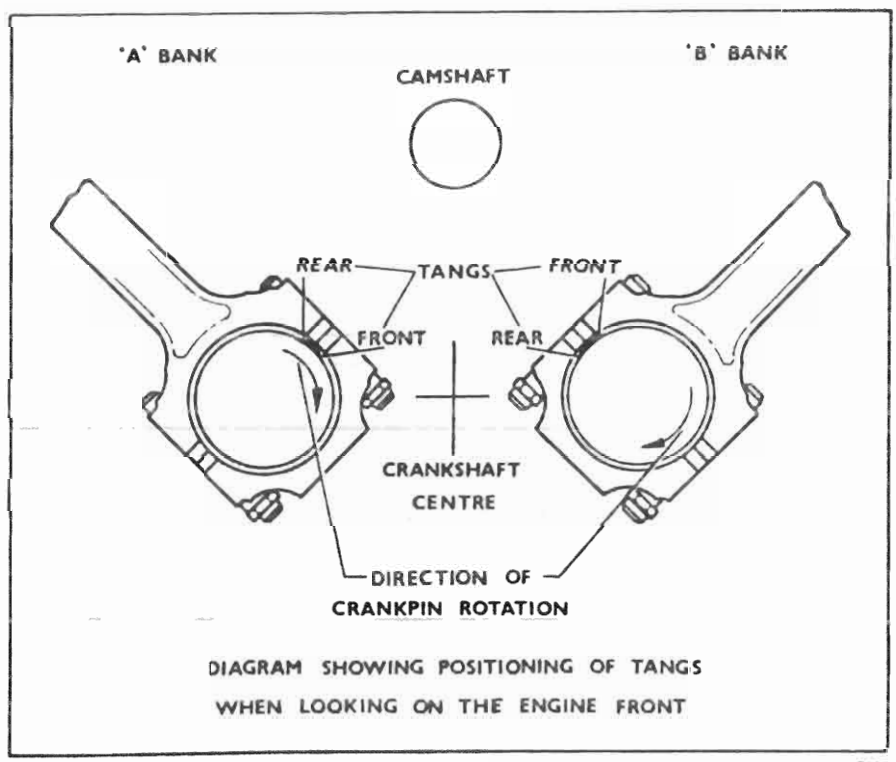


**Fig. E44 Positioning of connecting rod tangs**

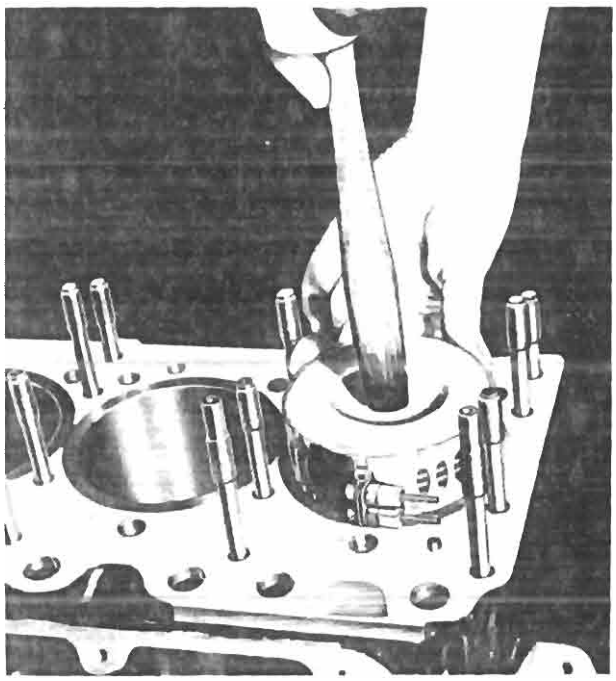

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Fig. E45 Method of fitting piston

top steel rail. Then fit the compression rings. The rings should be fitted from the top, thus avoiding any damage to the piston skirt. The compression ring is a chromuium plated ring and can be fitted either way up. The two intermediate taper rings can only be fitted one way. On one side they are marked 'Top' and this side must be fitted to the top of the piston.

To ensure that the gudgeon pin, piston and rod are always assembled in the same way, the following procedure should be observed. Fit the gudgeon pin to the piston so that the bore number on the pin is on the same side as the number on the piston. The tangs on the connecting rod and cap should always be nearest to the camshaft (see Fig. E44). For this to be correct when fitted to the engine, fit the connecting rods to 'A' bank pistons with the tangs on the rods on the opposite sides to the numbers of the pistons. With 'B' bank pistons fit the rods so that the tangs are on the same sides as the piston numbers.

**Connecting rods and pistons — To fit**

Liberally cover the pistons with graphogen and then fit a ring compressor over the piston rings. Tap the connecting rod bolts into the rod The bolts have a knurled diameter and should be an interference fit in the rod Fit the shells to the connecting rod and cap These shells should have the number of the bore etched on them and should be in pairs. Place rubbers on the ends of the connecting rod bolts. This prevents any possibility of damage to the big-end journals when fitting the rods Fit the piston into the bore from the top, ensuring that the piston is in the right bore, that the number of the piston is to the front of the engine, and that the tang on the connecting rod is nearest to the camshaft. Tighten the ring compressor and hold it against the liner, then push the piston into the bore (see Fig. E45). Remove the rubbers from the connecting rod bolts and fit the connecting rod cap to the rod; the tang on the cap should be on the same side of the journal as the tang on the rod. Fit the nuts to the bolts and tighten them to a torque loading of 32 lb. ft. This reading should give 0.005 in. bolt stretch If it does not, further tighten the bolts until the correct extension is obtained.

# Section E12
# VALVE GEAR

**Description**

Both the inlet and exhaust valves on early and late S2 engines are of the overhead type, operated through the medium of hydraulic tappets and push rods from a centrally located camshaft, as shown in Figure E46.

The exhaust valves are of KE.965 steel and have Stellite tips and seats, whilst the heads of the valves are 'Brightray coated' as a precaution against pre-ignition. The inlet valves are of either EN 24 or S.65 steel

Single springs are fitted to both the inlet and exhaust valves and are held in position by valve washers and split collets. The collets have bonded rubber tips on one edge to provide controlled oil lubrication to the valve stems.

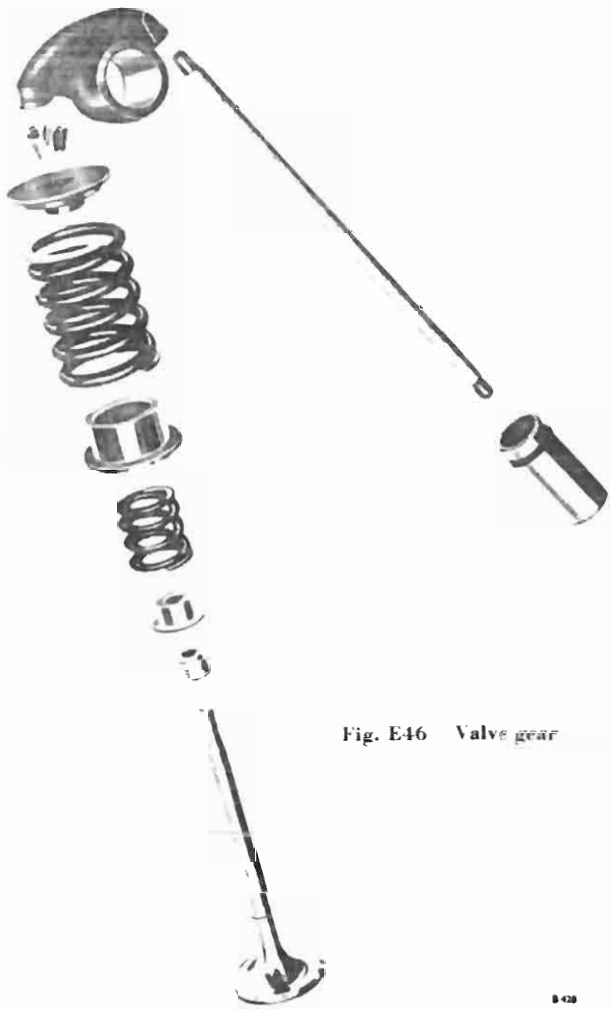

Fig. E46 Valve gear

On later S2 engines, the bottom washer of both the inlet and exhaust valves has been modified to incorporate a conical gland around the valve stem.

The tops of the valve guides have a concave chamfer to provide adequate seating for the gland, and the valve stems have been modified to prevent damage to the gland.

The gland is held in position by means of a housing which fits inside the modified bottom washer, the two being separated by a spring. This spring maintains the pressure of the housing on the gland.

The rocker shafts, rockers and spacing springs are carried on five pedestals mounted on extensions of the cylinder head studs. The rockers are drilled to provide delivery of oil from the rocker shafts to the valve tips and stems.

In the unlikely event of lubrication failure, certain modifications have been made to the rockers and rocker shafts.

The detachable bearings, which were fitted into rockers on early S2 engines have been deleted and the rocker is now hardened all over, including the bore.

Flats have been machined on the rocker shafts to improve the flow of oil to the rockers.

The new rockers must never be fitted as a replacement without the flatted rocker shaft; equally, the flatted rocker shaft cannot be fitted without the new hardened rockers.

The hydraulic tappets are carried in detachable blocks fitted in the crankcase on either side of the camshaft. The tappets are self-adjusting and require a minimum amount of attention. The tappet barrels are of hardenable case iron and have a spherical base of 35 in. radius. These tappets seat on a Monikrom iron camshaft, the

Fig. E47 Exploded view of hydraulic tappet

cams of which have a 5′ to 7′ taper and rotate the tappets, thus ensuring even wear of the tappet barrels.

To improve lubrication of the tappet block bores, a modification has been carried out on the tappet. A longitudinal flat has been machined on the tappet barrels. This flat acts as an oil trough, and as the tappet revolves, oil is circulated around the tappet block bores.

## HYDRAULIC TAPPETS (see Fig. E47)

**Description**

The hydraulic tappet consists of a cylindrical barrel, closed at the bottom end, upon which the cam acts. Inserted into this main body is a plunger which is free to slide up and down; the clearance between the body and the plunger is very closely controlled to fine limits. At the lower end of the plunger is a one-way valve, this is held lightly in a closed position by a wave washer which is in turn located in a retainer spigoted on to the plunger. The upper end of the plunger carries a cap in which the push rod seats. The whole plunger assembly is spring-loaded away from the base of the tappet body; this assembly is secured in position by a circlip fitted to the upper end of the tappet barrel.

**Hydraulic tappets — To remove**

A tappet which is found to be defective whilst in service should be replaced by a complete assembly and not by renewing any individual components.

It is recommended that the tappets are removed in the following manner.

Disconnect the battery leads.

Disconnect the air silencer hosing from the air silencer and butterfly housing.

Remove the air silencer.

Drain the cooling system into a suitable container if it is intended to use the coolant again. Three drain taps are provided, one at the bottom of the radiator matrix and one on either side of the crankcase.

Remove the two hoses from the coolant thermostat housing.

The engine electrical wiring system is carried in a loom, clipped to the induction manifold and should be disconnected at the following points.

The coolant temperature indicator.

The generator terminals.

The automatic choke solenoid.

The ignition coil.

Disconnect the throttle linkage to the carburetters.

Disconnect the throttle valve control linkage at the rear of 'B' bank cylinder head.

Remove the two rubber vacuum lines from the induction manifold. (Applicable to Phantom V, Long Wheelbase and Bentley Continental cars.)

Slacken the bolts securing the generator, and then remove the driving belts.

Remove the generator which is secured to the two-tier manifold and the coolant pump.

Disconnect the throttle valve linkage from the carburetters, and remove the petrol feed pipes.

Remove the two choke stove pipes from the 'A' bank exhaust manifold and the butterfly housing.

Remove the two air horns, the butterfly housing, the carburetters and the 'T' piece as a complete assembly. They are secured to the induction manifold by a single bolt, location being provided by two dowels.

Disconnect the high-tension lead from the coil, then unscrew the 16 setscrews securing the induction manifold to the cylinder heads, and remove the manifold together with the coil.

Remove the rocker covers.

Progressively unscrew the five setscrews securing the rocker pedestals to each cylinder head, then remove the rocker shaft assemblies.

Remove the push rods.

Unscrew the eight setscrews securing the tappet cover to the crankcase, and remove the tappet cover.

Remove the hydraulic tappets.

**Hydraulic tappets — To dismantle**

Press down the spherical cap situated in the top of the tappet, and remove the circlip holding the cap in place. Care should be taken when performing this operation that the spring pressure does not force out the tappet plunger. Remove the plunger and valve from the tappet barrel. The tappet barrel should be examined for any signs of wear on the base.

**Hydraulic tappets — To assemble**

In order to obtain the high degree of accuracy necessary for efficient operation of the hydraulic tappets, it is essential that extreme precautions are taken to ensure complete cleanliness when assembling.

It is therefore most important that particular attention is given to the following points:

Ensure that the assembly tank is perfectly clean before adding paraffin; only fresh, clean paraffin must be used.

Due to the highly critical surfaces and dimensions of the hydraulic tappets, great care must be taken when handling all the components.

Wash all the tappet components in clean paraffin, taking care that the components of each tappet are retained as an assembly and are not interchanged with parts of another tappet.

To avoid the possibility of misplacing any components the following method of assembly should be adopted.

Fit the wave washer in the valve retainer, then place the valve on top of the wave washer. Insert the spigot of the plunger into the valve retainer, then turn the assembly upside down to check the seating of the valve and wave washer.

Place the spring on to the valve retainer and whilst keeping the spring uppermost, insert the plunger into the tappet body which should be held upside down while immersed in paraffin.

Continue to maintain pressure on the plunger until the spring contacts the bottom of the tappet body, before turning the assembly upright.

Whilst keeping the assembly immersed in paraffin, place the plunger cap in position and press it down until it is possible to fit the circlip; to enable both hands to be used when fitting the circlip, a simple jig may be devised.

**Hydraulic tappets — To check the 'leak-down'**

The criterion of tappet performance is the 'leak-down' test, which is the time taken for the plunger to move down a specified distance inside the tappet under a given load.

The 'leak-down' test must be carried out when the tappet is primed with and immersed in clean paraffin, using the special fixture RH.7121, similar to that shown in Figure E48.

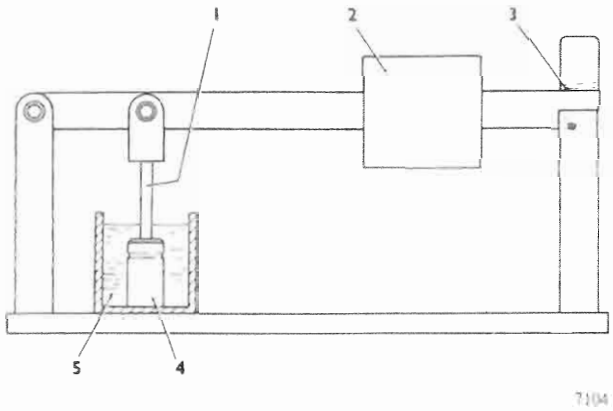


**Fig. E48 Checking 'leak-down' on hydraulic tappets**

The limits to which this test must conform are between 10 and 45 seconds for a plunger travel of $\frac{1}{8}$ in. under a load of 50 lb.; the measured plunger travel should end $\frac{1}{32}$ in. above the fully collapsed position

This 'leak-down' or movement of the plunger inside the body is required to ensure that at no time is the valve held off its seat.

**Hydraulic tappets — To fit**

To fit the tappets, reverse the procedure for their removal, noting the following points.

Oil the bores of the tappet blocks and check that if new tappets are fitted the grading of the tappet barrel is the same as the bore of the tappet block. Check also that the tappets are fitted in their correct positions. The grading and positioning marks are etched on the top lip of the tappet barrel.

Fit new joints to the induction manifold and to the tappet cover.

**Rockers — To remove**

The rockers should be removed as previously described in this section. When removing the shaft care should be taken that the spacing springs do not force the rockers and pedestals off the shaft. Remove the rockers, pedestals and springs from the shaft and place them in a suitable container so that the shaft may be readily assembled with the rockers in their original positions.

**Rockers — To renew**

The maximum permissible clearance on early S2 engines between the rocker bush and the rocker shaft is 0.0035 in., with a maximum of 0.015 in. wear on the rocker bush. If the clearance is in excess of this, the all hardened rockers should be fitted together with the modified rocker shafts.

***Rockers — To inspect***

Examine the pads on the rocker arms for wear and reface them if they are badly worn. Slight 'scuffing' or pitting on the pad may be removed with a smooth stone. The pads of the rockers are case hardened to a depth of 0.025 in. to 0.030 in. and the Rockwell hardness value should be between C57 to C65.

If, after refacing or stoning the rocker pads, the hardness value is below these figures, the rockers should be renewed.

**Rocker shaft — To assemble**

Fit the rocker pedestals, spacing springs and rockers to the rocker shaft. A spacing spring is fitted in between each pair of rockers. When building up the shaft it is advisable to put a peg through the end pedestal and the shaft to prevent it springing off when the remaining pedestals and springs are fitted. Ensure that the rockers are fitted in the correct place: they are left and right-handed and should be fitted in pairs so that the arms point in over the cylinder bore when the rocker shaft is in position on the cylinder head (see Fig. E49).

**Rocker shaft — To fit**

Fit the rocker shafts to the cylinder heads. The pedestals fit over the extensions of the cylinder head studs. These studs are tapped out and the rocker shaft is held down by five setscrews and washers. Fitted to each head is a dowel pin and this locates in a slot in the shaft, thus ensuring that the shaft is fitted the right way up with the

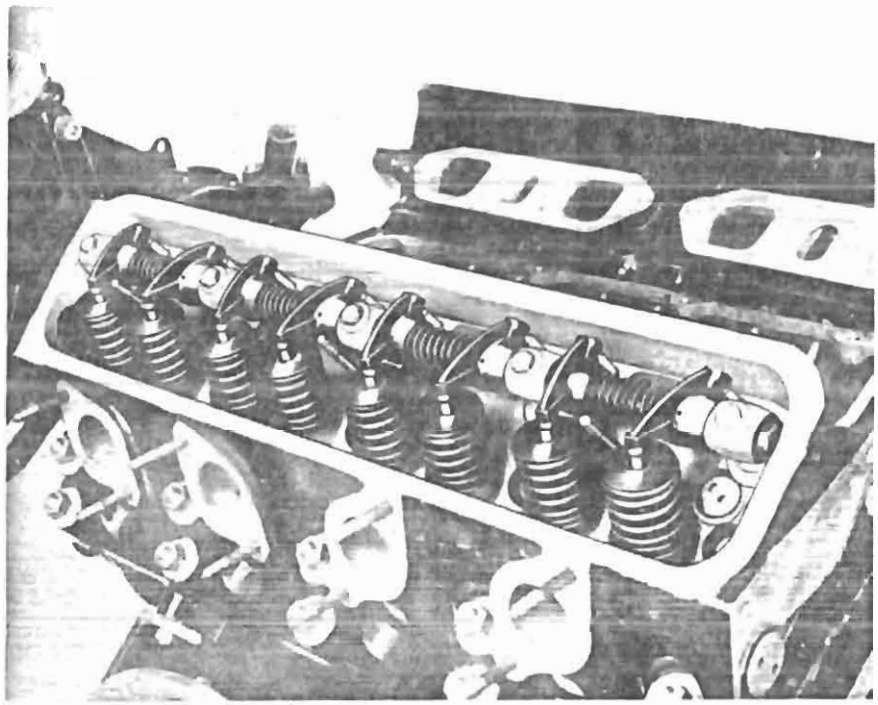

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Fig. E49 Rocker shaft assembly on cylinder head

oil holes in their correct position. When tightening down the five setscrews and washers that hold the shaft, ensure that the push rods are correctly seated in the tappet ball ends and also in the rockers

Tighten the shaft down progressively.

**Push rods**

The push rods are hollow and have hardened spherical ends. Whenever push rods are removed from the engine they should be examined and checked for bow. Any push rods that are out of truth should be replaced. The push rods have the corresponding tappet numbers etched on them and should always be fitted to the same tappets from which they were removed.

Before fitting the push rods check that the ball-ends are not blocked by dirt.

## Section E13

## CAMSHAFT

**Camshaft — To remove**

To remove the camshaft from the engine it is necessary to remove the engine and gearbox from the chassis frame, following the procedure described in Section E4.

Place the engine and gearbox in a suitable stand and remove the gearbox.

Remove the starter motor.

Remove the flywheel.

Remove the distributor.

Remove the induction system and cylinder heads as described in Section E7, then detach the tappet cover and withdraw the tappets.

Remove the coolant pump.

Remove the crankshaft pulley and the Metalastik damper from the front end of the crankshaft, using the special slotted spanner RH.7131, then withdraw the pulley driving flange, using the special tool RH.7097. Remove the lower front half casing which is dowelled to the crankcase.

Remove the pressed steel cover, fitted to the rear end of the crankcase.

Withdraw the locating plug and 'O' ring, the distributor driving shaft and the distributor driving gear from the rear end of the crankcase.

Remove the camshaft distributor skew gear from the rear end of the camshaft.

Remove the camshaft timing gear and end plate from the camshaft.

Remove the camshaft thrust plate, and then withdraw the camshaft through the front end of the crankcase.

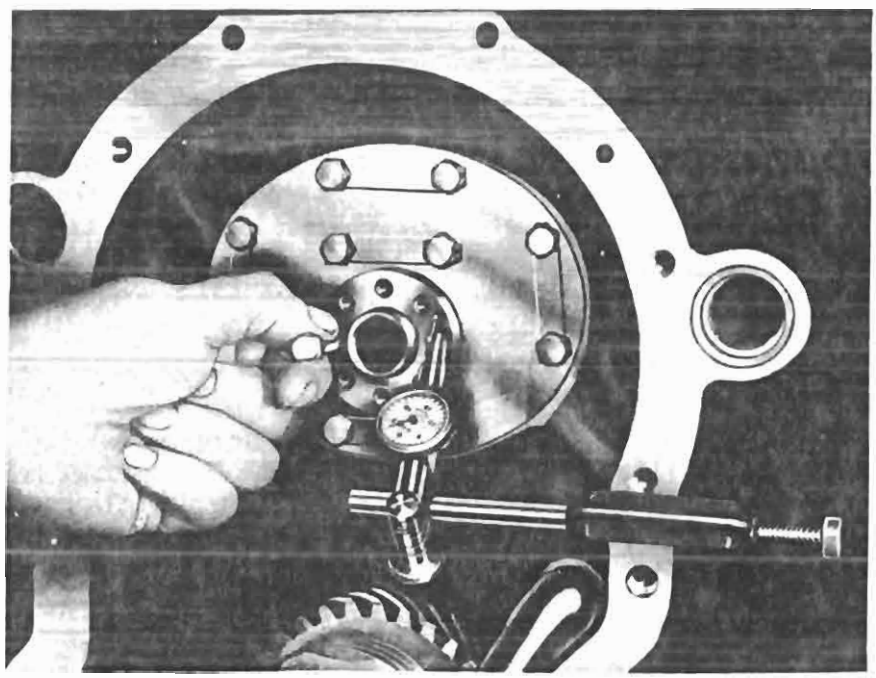

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**Fig. E50 Checking the camshaft end float**

**Camshaft and bearings — To inspect**

Inspect the cams for wear and pitting. The cam lift is 0.250 in. but a minimum lift of 0.235 in. is permissible. If wear is in excess of this figure, the camshaft must be renewed.

Examine the camshaft journals and bushes for wear. The maximum clearance between the bushes and the journals is 0.004 in. and if this figure is exceeded the bushes should be renewed as described in Section E5

**Camshaft — To fit**

Lightly smear the camshaft bearings with oil and fit the camshaft through the front end of the crankcase. Fit the camshaft thrust plate and secure it with ten setscrews and tabwashers. The setscrews should be tightened to give a torque loading of 8 to 10 lb. ft.

**Camshaft end float — To check**

Secure a dial indicator gauge in position on the front end of the crankcase (as shown in Fig. E50), ensuring that the clamp does not damage the machined surfaces, then check the camshaft end float. This operation will be simplified if two setscrews are screwed into the camshaft front end and used to move the shaft backward and forward.

The camshaft end float should be between 0.002 in. and 0.006 in.

**Camshaft timing gear — To fit**
**Valve gear — To time**

The camshaft and camshaft timing gear are both provided with an offset hole; thus they can only be assembled in one position. Examination of the timing gear and the crankshaft driving pinion will show that both gears are marked with a single line. The mark on the driving pinion is in relationship to the keyway on the crankshaft and the mark on the timing gear is in relationship to the offset hole in the camshaft; these two marks are used for timing the valve gear. The crankshaft should be rotated until the mark on the driving pinion is in a vertical position and to the top of the crankcase. Fit the camshaft timing gear to the camshaft so that the marking is to the bottom and in line with the crankshaft driving pinion marking

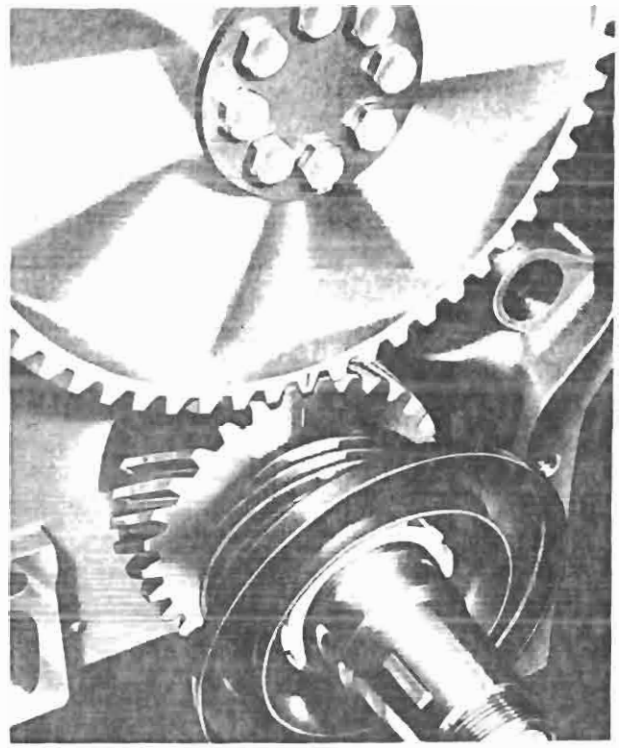

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Fig. E51 Valve timing marks

(see Fig. E51). Rotate the camshaft, holding the gear in position, until the threaded holes in the camshaft line up with the holes in the gear. Fit the end plate cover and secure the timing gear and the cover to the camshaft with *eight* setscrews. The torque loading for these setscrews is 8 to 10 lb. ft. The valve timing, if checked, should give a reading of 5° A.T.D.C.

**Camshaft timing gear backlash and run-out — To check**

1. ***Timing gear backlash***

Check the backlash between the timing gear and the crankshaft driving pinion by fixing the dial indicator in a suitable position at the front end of the crankcase (see Fig. E52). The backlash should be checked on various teeth around the circumference of the gears.

The camshaft timing gear backlash should be between 0.001 in. and 0.0035 in.

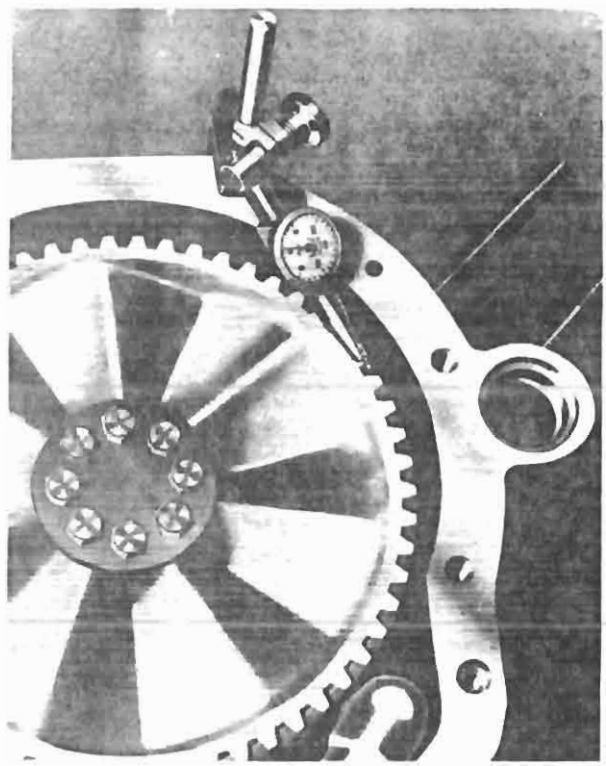

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**Fig. E52 Checking the timing gear backlash**

2. *Timing gear run-out*

Check the run-out on the front face of the timing gear, using a dial indicator gauge (see Fig. E53).

The gear run-out should not exceed 0.002 in.

**Camshaft distributor skew gear — To fit**

The camshaft distributor drive gear is fitted to the rear end of the camshaft and is secured by two setscrews and tabwashers, torque loaded to 8 to 10 lb. ft.

**Distributor driving gear — To fit**

Rotate the crankshaft until the timing marks on the camshaft and the crankshaft gears are in line. Fit the thrust washer to the distributor driving gear spindle, then fit the gear into the recess in the crankcase. It will help in fitting this gear if the washer is held to the gear with a slight smear of grease. When the gear is fitted it should be positioned so that the slot in the top of the gear spindle is parallel with the engine crankcase. On no account should the setting of the crankshaft and camshaft be disturbed whilst fitting this gear. Fit the distributor driving shaft to the driving spindle and then fit the locating plug. Renew the rubber 'O' ring on the locating plug if necessary.

Check the backlash of the distributor driving gear. This should be between 0.002 in. and 0.004 in.

Fit the camshaft rear cover, using a new paper joint.

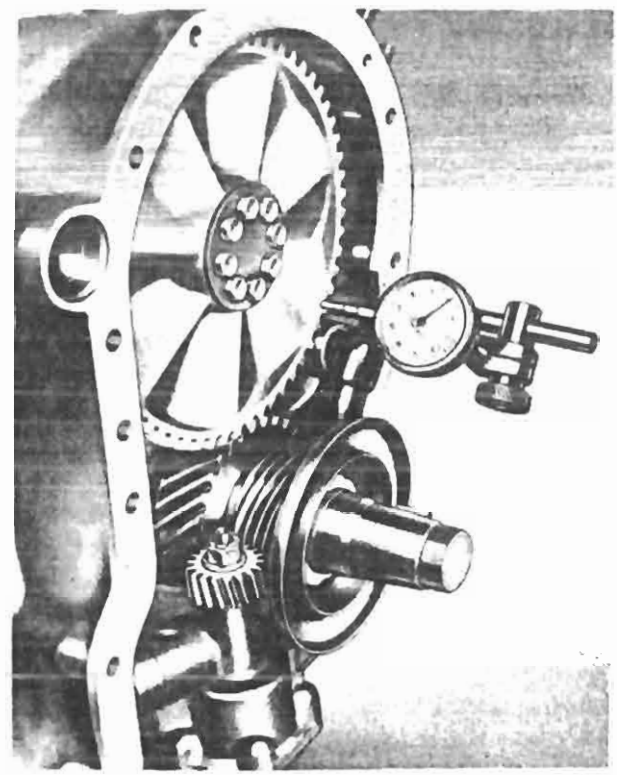

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**Fig. E53 Checking timing gear run-out**

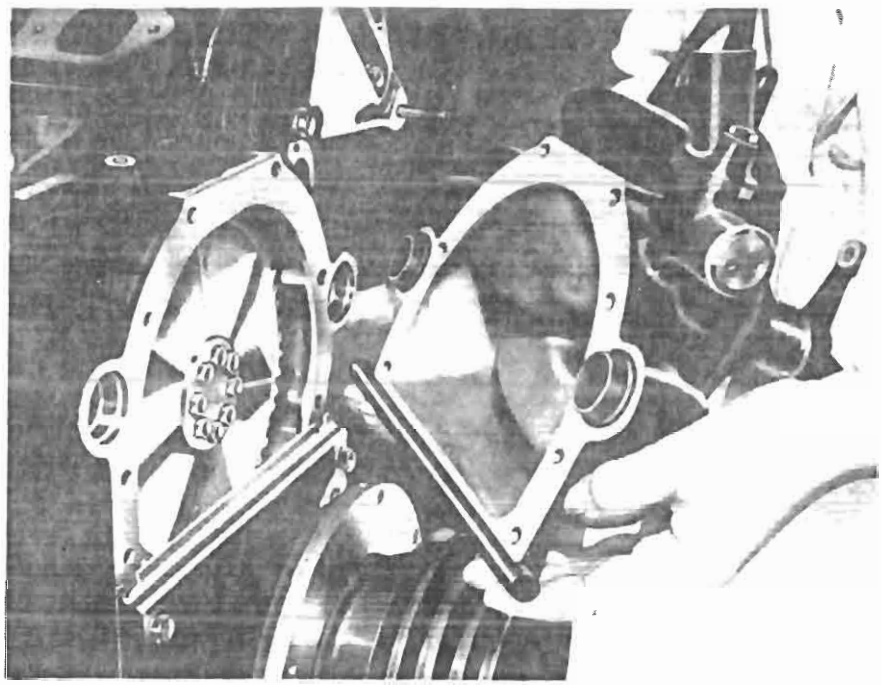


Fig. E54 Method of fitting coolant pump

Complete the assembly of the engine as follows:

Assemble the front end of the engine, fitting a new Neoprene oil seal between the lower front casing and the coolant pump (see Fig. E54).

Fit the cylinder heads, using new steel gaskets.

Fit the push rods, tappets and tappet cover, then fit the rocker shafts. The shafts should be tightened down progressively to avoid damage to the tappets.

Fit the flywheel.

**Ignition system — To time**

Fit the under cover of the bell-housing to the back of the crankcase. Rotate the engine until No. A.1 piston is on its compression stroke, then using the flywheel timing mark on the under cover, set the flywheel 2° B.T.D.C. When rotating the engine, only do so in a clockwise direction (i.e. normal rotational direction of the crankshaft), otherwise an inaccurate timing setting may be obtained due to backlash in the gears. The distributor drive shaft tongue should then be parallel with the engine (see Fig. E55).

Fig. E55 Method of fitting distributor

A micrometer-type octane selector is fitted to the distributor to permit the ignition timing to be retarded to suit low-grade fuels. The octane selector should be set to the fully advanced position before carrying out the ignition timing.

Turn the distributor spindle until the rotor arm is in line with No. 1 cylinder firing position.

Fit the distributor, securing the pedestal to the crankcase with two setscrews.

Release the distributor clamping screw, and rotate the body until the contacts are just breaking. During this operation hold the top of the rotor in the fully retarded position to take up any backlash in the centrifugal advance mechanism. Rotation of the distributor body in a clockwise direction will advance the timing, and in an anti-clockwise direction will retard the timing.

The most suitable method of checking when the contact points are just breaking is with an ignition timing lamp.

Tighten the clamping screw to lock the body in position.

Rotate the crankshaft two full turns and re-check, with the ignition timing lamp, that the contact points are just breaking when the rotor arm is in line with the No. 1 firing position.

**Contact points — To synchronize**

On later S2 cars an additional timing mark has been stamped on the engine flywheel for the timing of B4 cylinder while the distributor is in position on the crankcase.

To synchronize the contact points, rotate the crankshaft until the distributor rotor arm is in line with the B4 timing mark.

Release the distributor clamping screw and adjust the distributor so that the fixed contact points are beginning to open. During this operation, hold the rotor arm in the fully retarded (clockwise) position to take up any backlash.

Tighten the distributor clamping screw and rotate the flywheel in its normal direction until it is at 2° B.T.D.C. or A1 position (both these figures are stamped on the flywheel).

At this stage, the synchronizing points should just begin to open with the rotor arm held in the retarded position. If any further adjustment is necessary, release the two locking screws and adjust the synchronizing contact points to the correct position by means of the adjusting eccentric screw.

Tighten the two locking screws and check the synchronization.

Fit the distributor cap.

Fit the induction system, the starter motor and the gearbox.

Fit the engine to the chassis frame as described in Section E4.

## Section E14

# DECARBONISING

It is recommended that the engine be decarbonised every 20,000 to 25,000 miles.

To facilitate decarbonizing, RH.2068 decarbonizing set can be supplied.

**Cylinder heads — To remove**

The cylinder heads should be removed as previously described in Section E7.

**Carbon — To remove**

Remove the carbon deposits from the cylinder heads, the piston crowns and the top faces of the cylinder liners, using a blunt tool or wire brush; care should be taken that the heads, pistons and liners are not damaged. Wash the cylinder heads in paraffin and then blow off the surplus paraffin with compressed air. Remove all traces of carbon from the cylinder bores and the crankcase top faces, ensuring that carbon does not get into the coolant or oil drain holes.

**Valves — To remove**

The valves should be removed from the cylinder heads, using the special tool RH.7094, as previously described in Section E7.

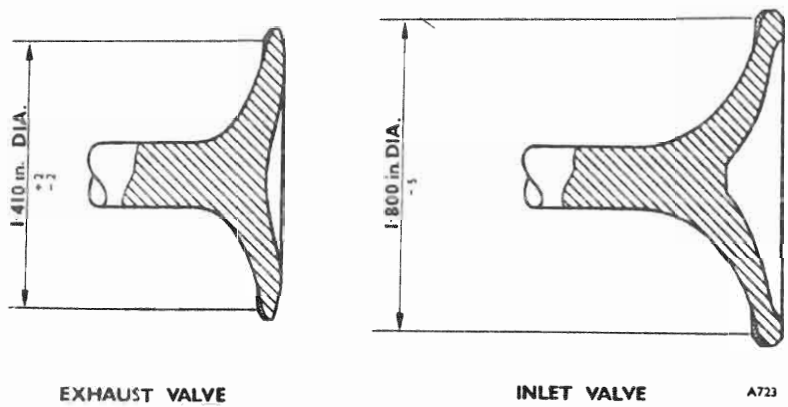
The valve spring, washer, split collets, valve, gland housing and gland pressure spring from each valve assembly should be retained as a separate assembly in order that they can be readily assembled in the head in their original positions. On initial assembly each valve stem is etched with the number of the position that it occupies in the engine.

**Valve guides — To Inspect**

The valve guides should be inspected for wear, using a new valve as a gauge.

The maximum permissible wear on both the inlet and exhaust valve guides is 0.0025 in. and, if this figure is exceeded, the guides should be renewed as described in Section E8. 'Bellmouthing' at the lower ends of the valve guides is permissible up to 0.006 in. for a depth of 0.375 in.

The maximum permissible clearance in the bore between the exhaust valve and the valve guide is 0.006 in. and between the inlet valve and the valve guide is 0.005 in.




Note: When retrimming the valve seats the material shown shaded thus ▤ should be ground off whilst maintaining the given dimensions

**Fig. E56 Valve seat dimensions**

**Valves and valve seat inserts — To reface**

The carbon should be removed from the valve heads and stems and the valve seat inserts with a wire brush or scraper.

The valve seats and the seat inserts should be refaced with suitable valve reconditioning equipment to give a seat angle of 45°. When refacing the valve seats, remove the minimum amount of material possible to give a 'clean' seating, whilst maintaining the two dimensions shown in Fig. E56.

The valve seat inserts may, if necessary, be crowned with a 30° cutter to prevent 'pocketing'.

If the valve seat inserts are badly worn they should be renewed as described in Section E9.

Lightly lap each valve to its seating, using a fine, good quality, lapping paste, then check the seating, using Prussian blue.

Wash the head and the valves in paraffin to remove all grinding dust and lapping paste. Blow off the surplus paraffin with compressed air.

If suitable valve reconditioning equipment is not available, the valves may be ground in by hand, using a medium lapping paste. Then lightly lap the valves to their seats, using fine lapping paste, and check the seatings with Prussian blue.

If new valve guides and valve seat inserts are fitted, the valve guides should be reamed before the valve seat inserts are faced.

**Valve springs — To test**

Visually examine the valve springs for defects, and then check the poundage of the springs on a valve spring tester.

Both the inlet and exhaust valve springs, when new, should require a poundage of 82 to 86 lb. to compress them to a length of 1.600 in. The minimum permissible poundage, when worn, is 71 lb.

**Cylinder heads — To assemble**

The cylinder heads should be assembled as described in Section E7. Ensure that the valves are fitted in their correct positions.

**Cylinder heads — To fit**

Fit the cylinder heads as described in Section E7, noting the following points:

Fit new cylinder head gaskets, using a jointing compound on both faces of the gaskets.

The cylinder head nuts should be tightened down progressively, working to the sequence shown in Fig. E27, to give a torque loading of 40 lb. ft.

**Final assembly and tuning**

Check the ignition timing as described in Section E13. This should be 2° B.T.D.C.

Remove the contact breakers and clean the points. Fit the contact breakers and set the gaps to 0.019 in. to 0.021 in.

Clean the sparking plugs and set the gaps to 0.024 in to 0.027 in.

Drain the sump and refill with clean oil

Renew the oil filter element and fit a new rubber sealing ring. Before fitting the filter bowl it should be cleaned out and filled with clean engine oil. The corners of the filter element must be turned over so that they do not become trapped by the filter head.

Fill the cooling system

Remove and clean the gauze filters in the fuel strainer, situated on the chassis cross-member in front of the petrol tank. Clean out the filter bowl and fit a new cork joint.

Remove and clean the gauze filters in the fuel inlets of the carburetters. Clean out the float chambers of the carburetters.

Start the engine and check for oil and coolant leaks.

Tune the carburetters as described in the Section on Carburetters in the Workshop Manual.

Fit the air silencer after first cleaning the paper element.

# Introduction

It is intended that this Supplement be read in conjunction with the Engine Manual (T.S.D. Publication 753) for the Rolls-Royce Silver Cloud II and Bentley S2. Where information in the Engine Manual differs from that contained in the Supplement, it is that in the Supplement which applies to the S3 engine.

Page numbers and figure numbers shown in parenthesis in this Supplement, refer to the Rolls-Royce Silver Cloud II and Bentley S2 Engine Manual.

The S3 engine is basically similar to the S2 engine, but a number of modifications have been incorporated which enable the engine to produce greater power and at the same time maintain a high degree of reliability.

## Chapter E

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## Section E2

# S3 ENGINE DATA

## SPECIFICATION

| | |
|---|---|
| Type | Over square 90° V formation, liquid cooled. |
| Number of cylinders | Eight—in two banks of four. |
| Bore | 4·100 in. |
| Stroke | 3·600 in. |
| Cubic capacity | 380·2 cu. in. (6,230 c.c.). |
| R.A.C. rated H.P. | 53·8. |
| Compression ratio | 9·1 for engines destined for North America, Japan and Europe except Portugal, Spain, Yugoslavia, Greece, Turkey, Finland, Malta, Holland and Cyprus.<br>*8:1 all other countries.* |
| Suspension | The engine and gearbox are of unit construction. The unit is flexibly mounted on rubber at three points. Single-point at the front and two-point at the rear. |

## CYLINDER BLOCK

| | |
|---|---|
| Type | Monobloc casting. |
| Material | Cast aluminium alloy. |

## CYLINDER LINERS

| | |
|---|---|
| Type | Detachable wet liners. |
| Material | Centrifugally spun cast iron. |

## CYLINDER HEADS

| | |
|---|---|
| Description | Two detachable heads, each having four separate inlet and exhaust ports. |
| Material | Aluminium alloy, with phosphor-bronze exhaust valve guides and cast-iron inlet valve guides and with exhaust and inlet valve seat inserts of austenitic steel. |

## CRANKSHAFT

| | |
|---|---|
| Description | Five journal crankshaft with four crankpins incorporating sludge traps. Integral balance weights and dynamically balanced. |
| Material | Chrome molybdenum steel with nitride hardened journals and crankpins. |
| Damper | Metalastik rubber vibration damper. |
| Direction of rotation | Clockwise. |

## MAIN BEARINGS

| | |
|---|---|
| Type | Split thin shells with 'pre-sized' bores to suit crankshaft journal diameter. |
| Material | Steel backed copper-lead with either lead-tin or lead-indium overlay. |
| Number | Five. |

## CONNECTING RODS

| | |
|---|---|
| Type | 'H' section. Forged to size and balanced. |
| Material | Chrome-molybdenum steel. |
| Big-end bearings | Steel backed copper-lead with either lead-tin or lead-indium overlay. |
| Gudgeon pin bushes | Pressed into connecting rod small-end bosses. |
| Material | Lead-bronze, steel backed. |

## PISTONS

9:1 compression ratio

| | |
|---|---|
| Type | Full skirt with a flat crown and offset gudgeon pin. |

8:1 compression ratio

| | |
|---|---|
| Type | Full skirt with a recessed crown and offset gudgeon pin. |
| Material | Aluminium alloy. |
| Number of rings | Four. Three compression rings and one oil control ring. Top compression ring is chromium plated. Bottom two compression rings have tapered edges. |

## VALVE GEAR

| | |
|---|---|
| Inlet valves | Overhead push rod operated. Single spring. Steel collets with rubber seals to control valve stem lubrication.<br>Seat angle 45°. |
| Material | EN 24 or S.65. |
| Exhaust valves | Overhead push rod operated. Single spring. Steel collets with rubber seals to control valve stem lubrication.<br>Seat angle 45°. |
| Material | KE 965. Stellite tips and valve seats. Brightray coated head. |
| Valve timing | 5° A.T.D.C. |
| Tappets | Self-adjusting hydraulic tappets with spherical base. |
| Material | Hardenable cast-iron. |
| Push rods | Ball-ended tubes. |

## CAMSHAFT

| | |
|---|---|
| Material | Cast Monikrom iron. |
| Cams | 5′ to 7′ longitudinal taper. |
| Number of journals | Four. |
| Bearings | Four babbit lined steel shells. |
| Thrust taken | On front end. |
| Drive | Through helical tooth gears. |

## LUBRICATION SYSTEM

| | |
|---|---|
| General | High pressure oil feed to crankshaft, connecting rods, camshaft bearings, tappets, push rods and rocker ball end seatings and camshaft timing gears. Intermittent oil feed through the front camshaft bearing to rocker shaft, rocker arms and valve tips. Splash feed to connecting rod small-ends, gudgeon pins and cylinder walls. |
| Type | Pressurised wet-sump system. |
| High pressure supply | 1,000 r.p.m. 37 lb./sq. in. |
| Relief valve | 40 lb./sq. in. |
| Sump capacity | Minimum—6 pt. (Imp.), 7·2 pt. (U.S.), 3·4 litres. Maximum—12 pt. (Imp.), 14·4 pt. (U.S.), 6·82 litres. |
| Oil pump | Helical gear type with fine mesh strainer pick up. |
| Oil filter | 'British Filters' Full Flow type with built-in relief valve. |

## FUEL SYSTEM

| | |
|---|---|
| Carburetters | Two S.U. H.D.8 diaphragm type 2·00 in. choke bores. Automatic choke for cold starting. |
| Air cleaner | Either a Purolator paper type element or an oil wetted wire mesh filter element depending upon which country the engine will be operating in. For details see latest Service Bulletin Section D, dealing with this subject. |
| Fuel pumps | Twin S.U. electric. |
| Fuel tank capacity | 18 galls. (Imp.), 21·6 galls. (U.S.), 81·8 litres. |
| Fuel strainers | Main fuel strainer mounted on the frame member in front of the fuel tank. Small gauze strainer at the carburetter inlets and in the fuel pumps. |
| Fuel gauge | Electric. Registers when the ignition is switched on. |

## COOLING SYSTEM

| | |
|---|---|
| Coolant capacity | 21 pt. (Imp.), 25·21 pt. (U.S.), 11·93 litres. |
| Pump | Centrifugal. |
| Fan | 5-blade. |
| Fan diameter | 18 in. |
| Pump and fan drive | $\frac{13}{16}$ in. adjustable 'V' belts. |
| Radiator matrix | Film type. |
| Coolant temperature control | 82°C.–86°C. |
| Temperature indicator | On instrument panel. Electric, registers when ignition switch is on. |
| Coolant | An inhibited solution of ethylene glycol (B.S.S. 3150). |

## EXHAUST SYSTEM

Through frame exhaust system. Large diameter pipes with two stainless steel resonators, and one stainless steel absorption damper in series. The front resonator is semi-acoustic and the rear resonator is fully acoustic.

## IGNITION DISTRIBUTOR

| | |
|---|---|
| Make and type | Lucas 20 D8. Eight lobe cam with double contact breakers, one contact breaker serves to make and the other to break the low tension circuit. |
| Rotation | Anti-clockwise. |
| Advanced mechanism | Automatic centrifugal advance with built-in vacuum timing control. |
| Ignition timing | 2° B.T.D.C. |
| Firing order | A1, B1, A4, B4, B2, A3, B3, A2. (1, 5, 4, 8, 6, 3, 7, 2). |
| Contact gap | 0·014 in.–0·016 in. |
| Drive | Through camshaft skew gears. |

## IGNITION COIL

| | |
|---|---|
| Make | Lucas. |

## SPARKING PLUGS

| | |
|---|---|
| 9:1 compression ratio | |
| Make and type | Champion RN.8. |
| 8:1 compression ratio | |
| Make and type | Lodge CLNP, Champion RN. 13P or Champion RN.8. |
| Gap | 0·025 in. |

## Section E3

# ENGINE DIMENSIONAL DATA

| DESCRIPTION | DIMENSION | PERMISSIBLE WORN DIMENSION | REMARKS |
|---|---|---|---|
| **CRANKCASE AND CYLINDERS** | | | |
| Cylinder liner bore grading .. | H. 4·100 in. — 4·1003 in.<br>J. 4·1004 in. — 4·1007 in.<br>K. 4·1008 in. — 4·1011 in.<br>L. 4·1012 in. — 4·1015 in.<br>M. 4·1016 in. — 4·1019 in. | 0·004 in. Wear.<br>0·003 in. Ovality. | If these measurements are exceeded a new assembly of liner and piston must be fitted. |
| Cylinder liner "nip" .. .. | 0·002 in. — 0·003 in | | New liners must be selectively fitted or ground on the end to give this dimension. |
| **PISTONS** | | | |
| Piston grading .. .. .. | H. 4·0985 in. — 4·0988 in.<br>J. 4·0989 in. — 4·0992 in.<br>K. 4·0993 in. — 4·0996 in.<br>L. 4·0997 in. — 4·1000 in.<br>M. 4·1001 in. — 4·1004 in. | | Piston clearance in the bore 0·0012 in. — 0·0018 in. measured 0·906 in. from the bottom of the skirt across the thrust axis. |
| Compression ring groove widths .. | 0·0807 in. — 0·0817 in. | | |
| Compression ring widths .. .. | 0·0777 in. — 0·0787 in. | | The rings should be assembled with staggered gaps. |
| Clearance .. .. .. .. | 0·002 in. — 0·004 in. | 0·005 in. | |
| Compression ring closed gap .. | 0·015 in. — 0·020 in. | 0·025 in. | |
| Open gap, nominal .. .. | 0·520 in. | | |
| Scraper ring groove width .. | 0·178 in. — 0·179 in | 0·181 in. | |
| Scraper ring width .. .. .. | 0·1755 in. — 0·1760 in. | | Neglecting spring. |
| Clearance .. .. .. .. | Nil. | | Clearance taken up by spring load. |
| Closed gap .. .. .. .. | 0·015 in. — 0·020 in. | 0·025 in. | |
| Open gap, nominal .. .. | 0·520 in. | | |
| **GUDGEON PINS** | | | |
| Bore diameter in piston .. .. | 0·9999 in. — 1·0001 in. | | |
| Gudgeon pin diameter .. .. | 1·0001 in. — 1·0003 in. | | |
| Interference in boss .. .. | 0·0002 in. | | By selective assembly at room temp. 68–72° F. |

| DESCRIPTION | DIMENSION | PERMISSIBLE WORN DIMENSION | REMARKS |
|---|---|---|---|
| **CRANKSHAFT AND CONNECTING RODS** | | | |
| Connecting rod small-end bush internal diameter .. .. .. | 1·0003 in. — 1·0005 in. | | |
| Clearance on gudgeon pin .. | 0·000 in. — 0·0004 in. | 0·0005 in. | At room temp. 68–72° F. |
| Big-end bearing housing, internal diameter .. .. .. .. | 2·395 in. — 2·3955 in. | | |
| Big-end bearing shell, internal diameter .. .. .. .. | 2·2505 in. — 2·2515 in. | | |
| Crankpin diameter.. .. .. | 2·2485 in. — 2·249 in. | 2·2475 in. | |
| Clearance .. .. .. .. | 0·0015 in. — 0·003 in. | 0·0035 in. | Clearance measured vertically. Renew bearings if lead plating is worn through. |
| Small-end bush housing, internal diameter .. .. . .. | 1·140 in. — 1·1405 in. | | |
| Small-end bush external diameter.. | 1·1425 in. — 1·144 in. | | Handpush fit in ring gauge. |
| Interference.. .. .. .. | 0·002 in. — 0·004 in. | | |
| Connecting rod and cap bolt holes. Diameter for location .. .. | 0·375 in. — 0·3755 in. | | On location diameter. |
| Connecting rod bolt diameter for location .. .. .. .. | 0·3745 in. — 0·375 in. | | On location diameter. |
| Clearance .. .. .. .. | Size — 0·001 in. | | |
| Connecting rod bolt diameter .. | 0·389 in. — 0·391 in. | | **On knurled diameter. Bolts should** not be removed from rods unless they are to be renewed. |
| Connecting rod and cap bolt diameter .. .. .. .. | 0·3838 in. — 0·3858 in. | | |
| Interference.. .. .. .. | 0·0032 in. — 0·0072 in. | | |
| Theoretical nip on connecting rod bearings shells .. .. .. | 0·003 in. — 0·008 in. | | |
| Connecting rod end float .. .. | 0·008 in. — 0·017 in. | | Controlled by clearance between rods and crankpin end faces. |
| Main bearing shell internal diameter: | | | |
| Theoretical .. .. .. | 2·501 in. — 2·502 in. | | Due to housing expansion under interference fit of shells. |
| Actual .. .. .. .. | 2·501 in. — 2·503 in. | | |
| Crankshaft journal diameter .. | 2·4995 in. — 2·500 in. | 2·4985 in. | |
| Clearance (Actual).. .. .. | 0·0015 in. — 0·0035 in. | 0·0045 in. | Renew bearings if lead plating is worn through. |
| Crankshaft end float .. .. | 0·004 in. — 0·010 in. | 0·012 in. | |
| Connecting rod bolt stretch .. | For 0·005 in. bolt stretch Torque load = 32 lb./ft. | | |

| DESCRIPTION | DIMENSION | PERMISSIBLE WORN DIMENSION | REMARKS |
|---|---|---|---|
| **MAIN BEARING HOUSINGS** | | | |
| Bore diameter .. .. .. | 2·6655 in. — 2·6660 in. | | This diameter should be checked with the main bearing cap nuts in position and torque loaded to 35 lb./ft. |
| **MAIN BEARING CAPS** | | | |
| Width of cap .. .. .. | 5·1005 in. — 5·1010 in. | | |
| Gap width . . .. | 5·1000 in. — 5·1010 in. | | |
| Interference . .. .. | 0·001 in. minus 0·0015 in | | |
| Cap nuts . .. .. | Torque load to 45 lb./ft | | When the bearing shells are in place. |
| **VALVE GEAR** | | | |
| Camshaft timing gear backlash .. | 0·001 in. — 0·0035 in | 0·005 in. | |
| True running of camshaft gear face | 0·000 in. — 0·002 in | | |
| Camshaft end float .. .. | 0·002 in. — 0·006 in. | | |
| Camshaft journal diameter . | 1·9975 in. — 1·998 in | 1·9965 in. | |
| Camshaft bearing, internal diameter | 2·000 in. — 2·0005 in. | 2·002 in. | |
| Camshaft journal clearance .. | 0·002 in. — 0·003 in. | 0·004 in. | |
| Camshaft bearing, external diameter | 2·129 in. — 2·1305 in. | | Hand push fit in gauge. |
| Crankcase bore — diameter for camshaft bearing .. .. | 2·125 in. — 2·1255 in. | | |
| Camshaft bearing interference in crankcase .. .. .. .. | 0·0035 in. — 0·0055 in. | | |
| Inlet cam and base circle — overall dimension .. .. .. .. | 1·465 in. — 1·470 in. | 1·455 in. | Cam lift is 0·250 in. Minimum permissible lift is 0·235 in. |
| Exhaust cam and base circle — overall dimension .. .. .. | 1·465 in. — 1·470 in. | 1·455 in. | Cam lift is 0·250 in. Minimum permissible lift is 0·235 in. |
| Tappet block bore diameter | Y. 0.90475 in. — 0.9050 in.<br>Z. 0.9050 in. — 0.90525 in. | | |
| Tappet external diameter.. | Y. 0.9040 in. — 0.90425 in.<br>Z. 0.90425 in. — 0.9045 in. | | |
| Clearance .. .. .. | 0·0005 in. — 0·001 in. | 0·0015 in. | |
| Tappet "leak-down" test .. | Time for a plunger travel of ¼ in. under a load of 50 lb. is 20–80 sec. Esso T.S.D.1047 paraffin must be used. | A "leak-down" time of 10–80 sec. will be accepted in service. | This "leak-down" time is critical and any tappet outside these figures should be replaced with a complete assembly. Parts must not be interchanged. |

| DESCRIPTION | DIMENSION | PERMISSIBLE WORN DIMENSION | REMARKS |
|---|---|---|---|
| Exhaust valve guide — external diameter .. .. .. .. | 0·6275 in. — 0·628 in. | | |
| Cylinder head bore diameter for exhaust valve guide .. .. | 0·625 in. — 0·626 in. | | |
| Interference in head .. .. | 0·0015 in. — 0·003 in. | | |
| Exhaust valve guide — internal diameter .. .. .. .. | 0·3755 in. — 0·376 in. | 0·378 in. | "Bellmouth" at the lower end is permissible up to 0·006 in. for a depth of 0·375 in. |
| Exhaust valve stem diameter .. | 0.37175 in. — 0·372 in. | 0·3705 in. | |
| Clearance .. .. .. .. | 0·0035 in. — 0·00425 in. | 0·0060 in. | |
| Exhaust valve spring compressed 1·600 in. .. .. .. .. | 82 — 86 lb. | 71 lb. | |
| Exhaust and inlet valve seat angle | 45° minus 1/10° | | "Crown" with 30° cutter to avoid pocketing after regrinding seat. |
| Exhaust valve seat insert external diameter .. .. .. .. | 1·7540 in. — 1·7545 in. | | |
| Cylinder head bore for seat insert .. | 1·750 in. — 1·751 in. | | |
| Interference .. .. .. | 0·003 in. — 0·0045 in. | | |
| Inlet valve seat insert external diameter .. .. .. .. | 2·0290 in. — 2·0295 in. | | |
| Cylinder head bore diameter for seat insert .. .. .. .. | 2·025 in. — 2·026 in. | | |
| Interference .. .. .. .. | 0·003 in. — 0·0045 in. | | |
| Inlet valve guide, external diameter | 0·6275 in. — 0·628 in. | | |
| Cylinder head bore diameter for inlet valve guide .. .. .. | 0·625 in. — 0·626 in. | | |
| Interference in head .. .. | 0·0015 in. — 0·003 in. | | |
| Inlet valve guide, internal diameter | 0·3755 in. — 0·376 in. | 0·3773 in | |
| Inlet valve stem diameter .. | 0·3735 in. — 0·374 in. | 0·3723 in. | |
| Clearance .. .. .. .. | 0·0015 in. — 0·0025 in. | 0·005 in. | |
| Inlet valve spring compressed to 1·600 in. .. .. .. .. | 82 — 86 lb. | 71 lb. | |
| Exhaust valve—overall length .. | 5·033 in. | | |
| Inlet valve—overall length .. | 5·075 in. | | |
| Distributor gear backlash .. | 0·002 in. — 0·004 in. | 0·008 in. | |

| DESCRIPTION | DIMENSION | PERMISSIBLE WORN DIMENSION | REMARKS |
|---|---|---|---|
| Rocker bore diameter .. .. | 0·74925 in. — 0·74975 in. | 0·751 in. | |
| Rocker shaft diameter .. .. | 0·74825 in. — 0·7485 in. | | |
| Clearance .. .. .. .. .. | 0·00075 in. — 0·0015 in. | 0·0035 in. | |
| **OIL PUMP** | | | |
| Driving shaft diameter .. .. | 0·4990 in. — 0·4995 in. | 0·4970 in. | |
| Shaft bore diameter .. .. | 0·500 in. — 0·5005 in. | | |
| Shaft clearance in casing bore .. | 0·0005 in. — 0·0015 in. | 0·003 in. | |
| Stationary spindle diameter .. | 0·499 in. — 0·4995 in | 0·4965 in. | |
| Driven gear internal diameter .. | 0·500 in. — 0·5005 in | 0·5015 in. | |
| Clearance on spindle .. .. | 0·0005 in. — 0·0015 in. | 0·003 in. | Permissible only when the radial clearance of the gears in the case exceeds this figure. |
| Diametrical clearance between gears and side of chamber .. | 0·0020 in. — 0·0035 in. | 0·006 in. | |
| Pump gears—backlash .. .. | 0·0005 in. — 0·0025 in. | 0·004 in. | |
| Pump gears—end float .. .. | 0·001 in. — 0·004 in. | 0·005 in. | |
| Drive gear backlash .. .. | 0·0012 in. — 0·0033 in. | 0·008 in. | |
| **CYLINDER HEAD STUDS** | | | |
| Stud diameter .. .. .. | Yellow 0·405 in. — 0·404 in.<br>Red 0·404 in. — 0·403 in.<br>Blue 0·403 in. — 0·4019 in. | | Studs must be matched to hole, colour for colour. |
| Threaded hole diameter .. .. | Yellow 0·404 in. — 0·403 in.<br>Red 0·403 in. — 0·402 in.<br>Blue 0·402 in. — 0.401 in. | | |
| Interference | 0·000 in. to 0·002 in. | | |
| **MAIN BEARING HOUSING STUDS** | | | |
| Stud diameter .. .. .. | Yellow 0·4675 in. — 0·4665 in.<br>Red 0·4665 in. — 0·4655 in.<br>Blue 0·4655 in. — 0·4643 in. | | Studs must be matched to hole, colour for colour. |
| Threaded hole diameter .. .. | Yellow 0·4665 in. — 0·4655 in.<br>Red 0·4655 in. — 0·4645 in.<br>Blue 0·4645 in. — 0·4635 in. | | |
| Interference .. .. .. | 0·000 in. to 0·002 in. | | |

**OIL PUMP RIG TEST PERFORMANCE**

Oil temperature to be 80°C. (176°F.).

| Pump R.P.M. | Restricting Orifice Diameter (inches) | Permissible Minimum Pressure (lb./sq. in) |
|---|---|---|
| 500 | 0·150 — 0·002 | 32 |
| 1,000 | 0·105 — 0·002 | 37 |
| 1,500 | 0·150 — 0·002 | 40 |
| 180 | 0·100 — 0·002 | 25 minimum |

**OIL PUMP RELIEF VALVE SPRING**

Free length—1·975 in.

Load when compressed to 1·125 in.—11½ lb.

## Section E4

## ENGINE

**General description** (*Page E15 in Engine Manual*)

**First paragraph to read:—**

The Rolls-Royce power unit is an over square 'V' engine, having eight cylinders and operating on the four-stroke cycle. It has a bore of 4·100 in. and a stroke of 3·600 in. giving a total capacity of 380·200 cu. in (6,230 c.c.). The compression ratio of the power unit can be either 9·00 : 1 or 8·00 : 1 depending upon which country it will be operating in.

**Fourth paragraph to read:—**

The nitride hardened dynamically balanced crankshaft is a forging of chrome molybdenum steel, provided with sludge traps in each of the four crankpins and integral balance weights; it is carried in five bearings. These bearings consist of thin steel shells, lined with copper lead indium; the bearings are held in position by forged aluminium bearing caps. Crankshaft end thrust is taken by the centre main bearing, which is fitted with thrust pads at both front and rear.

**Sixth paragraph to read:—**

The pistons are of aluminium alloy with fully floating gudgeon pins. Engines having a compression ratio of 9·00 : 1 are fitted with pistons having full skirts and flat crowns; these pistons are carried on hardened steel gudgeon pins which are offset to the centre line of the piston.

Engines having a compression ratio of 8·00 : 1 are fitted with pistons having full skirts and recessed crowns; these pistons are carried on hardened steel gudgeon pins which are offset to the centre line of the piston.

Four rings are fitted to each piston — three compression rings and one oil control ring.

**First paragraph to read:**—(*Page E16 in Engine Manual*)

Air is filtered through either an oil soaked wire mesh filter element or a Purolator paper type, depending upon which country the engine will be operating in.

After passing through the filter element the air is drawn through the carburetters, which are mounted on a 'T' piece over an eight-branch induction manifold.

An automatic choke mechanism is provided for cold starting.

The remaining information is applicable to the S3 engine.

## Section E6

# ENGINE LUBRICATION

Stage 1 (*Page E25 in Engine Manual*) is not applicable to the S3 engine.

Stages 2 and 3 (*Page E25 in Engine Manual*)

**Second paragraph to read:—**

The camshaft timing wheel and driving pinion are lubricated by a high pressure jet of oil sprayed directly between the two gears: the feed for this jet is via an adaptor on the oil gallery cover plate. See Fig. 1.

Oil pump (*Page E26 in Engine Manual*)

**Third paragraph to read:—**

The oil pump driven gear runs on a steel spindle pressed into the pump casing.

The driven gear is not now fitted with a pressed-in bush.

Oil pump—To assemble (*Page E28 in Engine Manual*)

**Fourth paragraph is not applicable to the S3 oil pump**

To change the oil filter element (*Page E29 in Engine Manual*)

**First paragraph to read:—**

The felt element of the filter should be renewed every 6,000 miles.

**Engine lubrication diagram**

The 'Pressure oil jet to camshaft timing gear' shown in Fig. E19 Engine lubrication diagram is not applicable to the S3 engine.

The remaining information in this Section is applicable to the S3 engine.

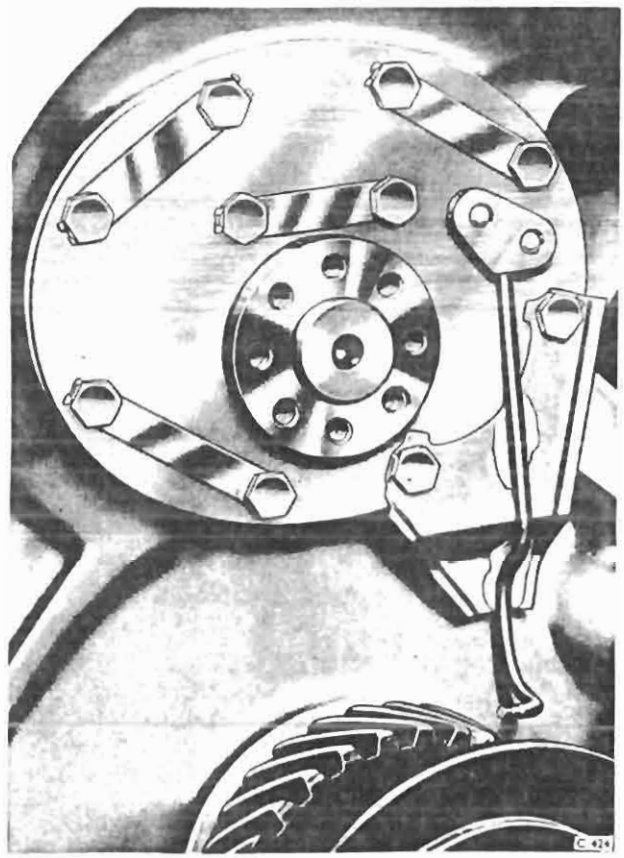


**Fig. 1. View of timing gears lubricating jet.**

## Section E7

# CYLINDER HEADS

**Description** (*Page E31 in Engine Manual*)

**The fifth paragraph is not applicable to the S3 engine**

The cylinder heads are the same irrespective of compression ratio, the difference being effected by the pistons.

**Cylinder heads—To remove (with the engine in the car)** (*Page E31 in Engine Manual*)

**This paragraph to follow the thirteenth paragraph in the Engine Manual:—**

Remove the crankcase breather tube from the oil filler pedestal and butterfly housing.

**Cylinder head—To fit** (*Page E33 in Engine Manual*)

**Fifth paragraph to read:—**

Clean the flame traps in the crankcase breather tube by washing them in petrol and drying them with a high pressure air line.

Before re-fitting the union to the oil filler pedestal check the condition of the rubber sealing rings and renew if necessary.

The remaining information in this Section is applicable to the S3 engine.

## Section E10

# CRANKSHAFT AND MAIN BEARINGS

**Description** (*Page E39 in Engine Manual*)

The crankpins of the crankshaft are drilled and plugged, as shown in Fig. 2; in this way sludge traps are formed in each of the crankpins, and by means of centrifugal force retain any dirt which may be held in suspension in the oil. This prevents any dirt from reaching the bearings thus reducing wear.

To further reduce wear, the crankshaft is nitride hardened all over.

The paragraph headed **Note** in the description is not applicable to the S3 engine.

The remaining information in the description is applicable to the S3 engine.

**Crankshaft—To remove** (*Page E40 in Engine Manual*)

This section is applicable to the S3 engine with the addition of the following.

**Crankshaft sludge traps—To dismantle**

Remove the circlips and withdraw the oil sealing plugs; these plugs can be removed with the aid of a setscrew or stud screwed into the tapped extractor hole.

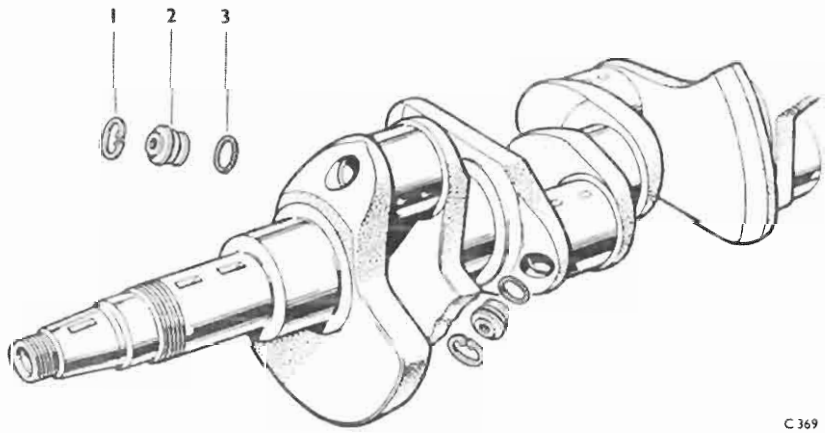
Wash all parts in clean paraffin, paying particular attention to the oilways and sludge traps.

**Crankshaft—To regrind** (*Page E41 in Engine Manual*)

The crankshaft should be reground when wear or ovality exceeds 0·001 in. or when the crankpins or journals are heavily scored.

Undersize bearings are available in sizes ranging from minus 0·010 in. to minus 0·040 in. in steps of 0·010 in.

The crankshaft journals and crankpins should be reground and lapped to the nearest of the following dimensions which will give a true diameter.




1. CIRCLIP.
2. OIL SEALING PLUG.
3. RUBBER SEALING RING.

**Fig. 2. Exploded view of crankshaft sludge traps.**

| | Crankshaft Journal | Main Shell Bearing |
|---|---|---|
| Standard | 2·500 in.—0·0005 in. | 2·501 in. + 0·001 in. |
| 0·010 in. undersize | 2·490 in.—0·0005 in. | 2·491 in. + 0·001 in. |
| 0·020 in. undersize | 2·480 in.—0·0005 in. | 2·481 in. + 0·001 in. |
| 0·030 in. undersize | 2·470 in.—0·0005 in. | 2·471 in. + 0·001 in. |
| 0·040 in. undersize | 2·460 in.—0·0005 in. | 2·461 in. + 0·001 in. |

*ACTUAL* RUNNING CLEARANCE 0·0015 in. to 0·0035 in.
MAXIMUM PERMISSIBLE CLEARANCE 0·0045 in.

| | Crankpin | Big-end Bearing |
|---|---|---|
| Standard | 2·249 in.—0·0005 in. | 2·2505 in. + 0·001 in. |
| 0·010 in. undersize | 2·239 in.—0·0005 in. | 2·2405 in. + 0·001 in. |
| 0·020 in. undersize | 2·229 in.—0·0005 in. | 2·2305 in. + 0·001 in. |
| 0·030 in. undersize | 2·219 in.—0·0005 in. | 2·2205 in. + 0·001 in. |
| 0·040 in. undersize | 2·209 in.—0·0005 in. | 2·2105 in. + 0·001 in. |

RUNNING CLEARANCE 0·0015 in. to 0·003 in.
MAXIMUM PERMISSIBLE CLEARANCE 0·0035 in.

When grinding use a stone having a grit and grade equivalent to a NORTON A46 M5V or one grade softer. **A harder stone must not be used.**

For 'plunge' grinding the width of the stone must be 0·020 in. less than the dimension between the journal or crankpin end faces and the machine must be fitted with hydraulic stops. For traverse grinding a suitable width of stone should be selected (see Fig. E34 in Engine Manual).

Care must be taken to ensure that no sharp ridges are left in the radii where the grinding wheel traverse ends and the radii of the grinding wheel must be carefully controlled to ensure that the grinding fades out not more than half-way up the radius on the crankshaft.

**On no account must the grinding wheel touch the side faces of the crankpin or journal.**

Lubrication must be continuous during re-grinding and the lubricant should be fed liberally on to the ingoing side of the grinding wheel. The grinding wheel must not be allowed to contact the journal or crankpin until the shaft is thoroughly wet. Any approved lubricant can be used.

Grind the crankpins or journals until they are 0·001 in. larger than the required finish size; this will allow for lapping and polishing.

Crankshafts which have been ground to the first undersize, namely minus 0·010 in. will not need to be rehardened.

Crankshafts ground to any of the subsequent undersizes, namely minus 0·020 in., 0·030 in. and 0·040 in., **must be rehardened** by the nitride process.

After rehardening, test the hardness of the journals and crankpins; the minimum acceptable figure for a rehardened crankshaft is 570 VPN/30 kg. using a Vickers Diamond Pyramid machine.

After grinding and if the necessary equipment is available, the shaft should be magnetically crack tested. It should then be lapped and polished to the finished size.

**Crankshaft—To lap**

The crankshaft journals and crankpins should be lapped to produce a perfectly smooth finish after grinding or hardening.

Cast iron laps should be used and the machine set to run at between 220 and 250 r.p.m.

The lapping compound should consist of a mixture of grade M. 303½ grit and sperm oil in the proportion of 2½ lb. of grit to 1 gallon of sperm oil. The compound must be mixed to a smooth consistency and injected into the laps at frequent intervals.

The crankpins and journals must be lapped parallel within 0·0001 in., whilst lapping, the size of the crankpins and journals should be checked frequently; allowances should be made for the slight contraction which will take place as the shaft cools.

After lapping, wash the crankshaft thoroughly in a high pressure paraffin wash; blow off any surplus paraffin with compressed air and dry the shaft with a soft lint free cloth.

When the shaft is dry, polish the crankpins and journals, using COROLITE 320 grade abrasive strip 1 in. wide, liberally lubricated with either sperm or mineral oil.

After polishing again wash the shaft and repeat the cleaning procedure.

**Crankshaft sludge traps—To assemble**

Carefully examine for damage the oil sealing plugs

and housings which form the crankshaft sludge traps. Fit new rubber sealing rings to the plugs.

To facilitate easy entry of each plug into its respective bore, lightly smear the sealing ring with engine oil, press the plug firmly 'home' and fit the circlip to secure it in the crankshaft.

(Figures E30, E31, E33, E35, E36 and E37 show the S2 crankshaft). The S3 crankshaft is similar to the S2 crankshaft, but has sludge traps in each of the crankpins as shown in Figure 2.

The remaining information in this Section is applicable to the S3 engine.

## Section E11

## CONNECTING RODS AND PISTONS

**Description** (*Page E47 in Engine Manual. See Fig. E38*)

**Third paragraph to read:—**

The big-end bearings are detachable and are split steel shells copper-lead lined with either lead-tin or lead-indium overlay. The small-end bush is split and has a steel backing lined with lead bronze. The bush is pressed into small-end boss and then reamed out to a final diameter of 1·003 in. + 0·0002 in.

**Fifth paragraph to read:—**

The pistons are of aluminium alloy, having full skirts which are cam ground to permit a close fit between the piston and the cylinder liner; after grinding they are tin coated to reduce friction between the bearing surfaces.

The pistons fitted to the majority of S3 engines have flat crowns and provide a compression ratio of 9 : 1.

In countries where only low octane fuel is available, pistons with a recessed crown are fitted to the engine and provide a compression ratio of 8 : 1.

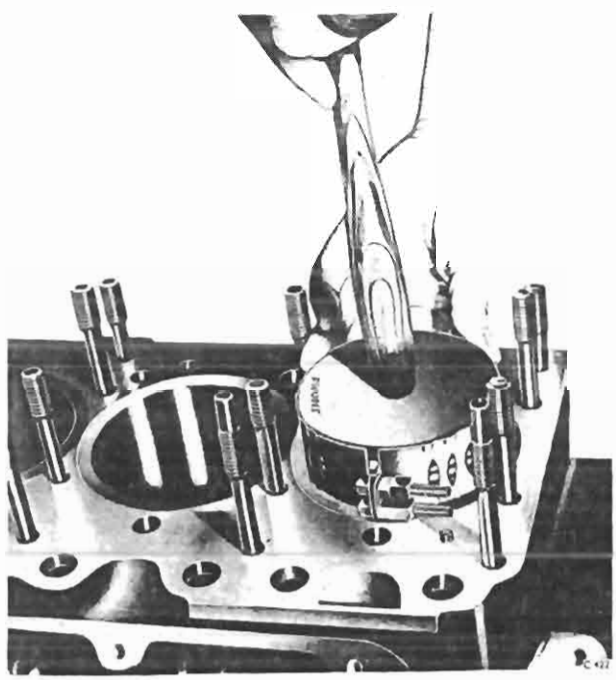



**Fig. 3. Method of fitting 9:1 compression ratio piston.**

The pistons are carried on gudgeon pins which are larger in diameter than those fitted in the S2 engine and are off-set to the centre line of the piston. Off-setting the gudgeon pins in this way compensates for the increased side thrust on the cylinder walls.

**Piston identification**

The 9 : 1 compression ratio pistons have a flat crown and off-set gudgeon pins which are larger in diameter than those fitted in the S2 engine.

The 8 : 1 compression ratio pistons have a recessed crown and off-set gudgeon pins which are larger in diameter than those fitted in the S2 engine.

The remaining information in the description is applicable to the S3 engine.

**Small-end bush—To renew** (*Page E50 in Engine Manual*)

**Fourth paragraph to read:—**

When fitted the bush should be diamond bored or reamed to the finished diameter of 1·0003 in. + 0·0002 in.

**Connecting rods and pistons—To reassemble** (*Page E52 in Engine Manual*)

**Fifth paragraph to read:—**

To ensure that the piston is fitted correctly relative to the connecting rod, the following procedure **must** be observed.

Due to the off-set gudgeon pin the piston is 'handed' as identified by the word 'FRONT' stamped on the crown, and **must** be fitted with the 'FRONT' towards the front of the engine.

Fit the connecting rod to the piston so that when assembled in the engine the tangs on the connecting rod and cap are nearest to the camshaft (see Fig. E44 Section E11 in Engine Manual).

The pistons shown in Figures E38, E41 and E45 in the Engine Manual are 8 : 1 compression ratio pistons. The 9 : 1 compression ratio pistons are similar in appearance but have flat crowns. See Fig. 3.

The remaining information in this Section is applicable to the S3 engine.

## Section E12

## VALVE GEAR

**Hydraulic tappets—To check the 'leak-down'** (*Page E57 in Engine Manual*)

**Second and third paragraphs to read:—**

The 'leak-down' test must be carried out when the tappet is primed with and immersed in clean ESSO T.S.D. 1047 paraffin, using the special fixture RH.7121, (see Fig. E48 Section E12 Engine Manual).

The limits to which this test must conform are between 20 and 80 seconds for a plunger travel of $\frac{1}{8}$ in. under a load of 50 lb.; the measured plunger travel should end $\frac{1}{32}$ in. above the fully collapsed position.

The above 'leak-down' time is for a new tappet; in service a 'leak-down' time of 10–80 seconds is acceptable before replacing the complete assembly.

The remaining information in this Section is applicable to the S3 engine.

## Section E13

## CAMSHAFT

**Camshaft—To fit** (*Page E62 in Engine Manual*)

Lightly smear the camshaft bearings with oil and fit the camshaft through the front end of the crankcase. Fit the timing gear lubricating jet to the camshaft thrust plate securing it with two setscrews and tab washers. Fit the camshaft thrust plate and secure it with ten setscrews and tab washers. The setscrews should be tightened to give a torque loading of 8 to 10 lb./ft.

**Camshaft timing gear—To fit**

**Valve gear—To time** (*Page E62 in Engine Manual*)

A strengthened aluminium alloy timing gear is fitted to the S3 engine and is of a solid disc type construction as opposed to the fluted type fitted on S2 engines.

(Figures E51, E52, E53 and E54 show the S2 type timing gear).

**Distributor**

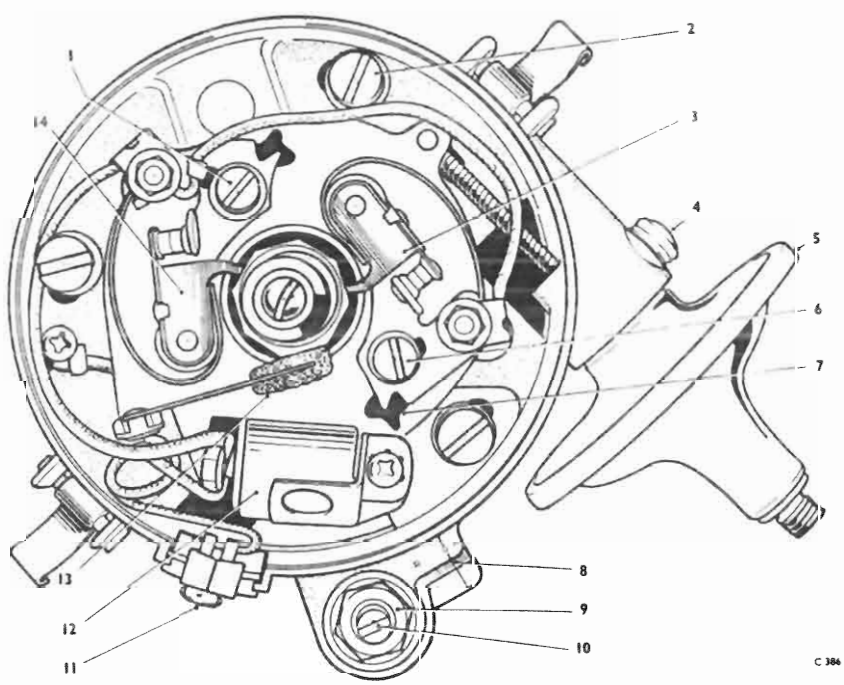
**Description**

A new type of distributor is fitted to the S3 engine, it has an eight lobe cam and is of the double contact breaker type; one contact breaker serving to make, and the other to break the low tension circuit. In addition to the centrifugal advance and retard mechanism, a vacuum timing control is provided, manifold depression being utilised to vary the timing in accordance with engine loadings.

**Ignition system—To time** (*Page E64 in Engine Manual*)

For identification of detail parts of the distributor, refer to Fig. 4.

Fit the under cover of the bell-housing to the back of the crankcase. Rotate the engine until No. A1, piston is on its compression stroke, then using the flywheel timing mark on the under cover, set the flywheel 2° B.T.D.C. The engine should be rotated clockwise (i.e. normal rotational direction of the crankshaft); if rotated otherwise an inaccurate timing setting may be obtained due to backlash in the gears. The distributor drive tongue should then be parallel with the engine crankshaft. See Fig. 5.




1. FIXED CONTACT PLATE SECURING SCREWS.
2. CONTACT BREAKER HOUSING SECURING SCREW.
3. CONTACT BREAKER.
4. VACUUM UNIT SECURING SCREW.
5. VACUUM TIMING CONTROL UNIT.
6. FIXED CONTACT PLATE SECURING SCREW.
7. CONTACT BREAKER GAP ADJUSTING SLOT.
8. OCTANE SELECTOR SCALE.
9. OCTANE SELECTOR ADJUSTING SCREW LOCKNUT.
10. OCTANE SELECTOR ADJUSTING SCREW.
11. L.T. TERMINAL.
12. CAPACITOR.
13. CAM LUBRICATING PAD.
14. CONTACT BREAKER.

**Fig. 4. Internal view of distributor.**

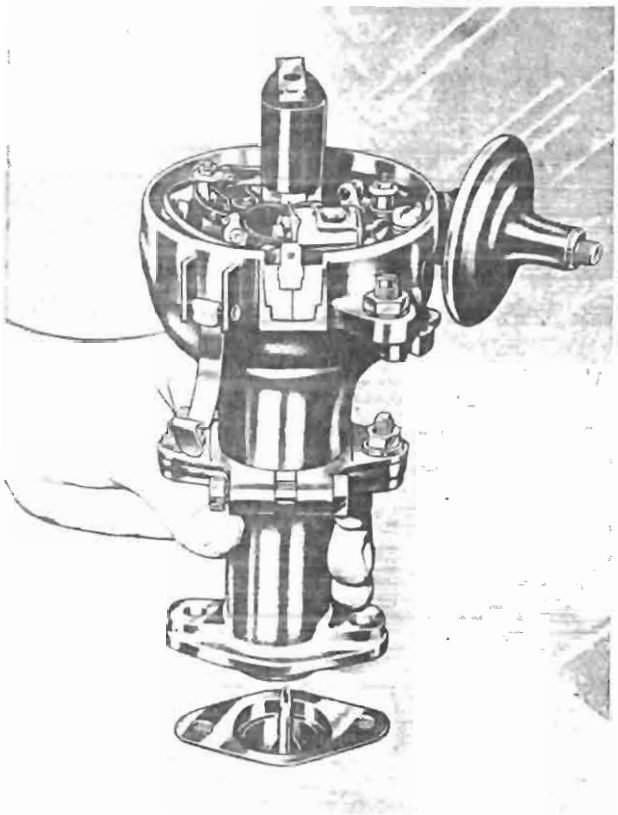


Fig. 5. Method of fitting distributor.

Release the locknut (9), and set the octane selector (8) to the fully advanced position (A) before carrying out the ignition timing.

Turn the distributor spindle until the rotor arm is in line with the No. A1 cylinder firing position.

Fit the distributor, securing the pedestal to the crankcase with two setscrews.

Release the distributor clamping screw, then rotate the body until the set of contacts (14), opposite the vacuum advance unit, are just breaking. During this operation hold the top of the rotor in the fully retarded position to take up any backlash in the centrifugal advance mechanism. Clockwise rotation of the distributor body will advance the timing, and anti-clock wise rotation will retard the timing.

The most suitable method of checking when the contact points are just breaking is with an ignition timing lamp.

Tighten the clamping screw to lock the body in position.

Rotate the crankshaft two full turns and with the ignition timing lamp, recheck to ensure that the contact points are just breaking when the rotor arm is in line with the No. A1 firing position.

Fit the distributor cap.

Fit the induction system, the starter motor and gearbox.

Fit the engine to the chassis frame (Page E18 in Engine Manual).

The remaining information in this Section is applicable to the S3 engine.

## Section E14

## DECARBONISING

*Page* E67 *in Engine Manual*

**Second paragraph to read:—**

To facilitate decarbonising, RH.2264 decarbonizing set can be supplied.

**Final assembly and tuning** (*Page E68 in Engine Manual*)

**First and second paragraphs to read:—**

Check the ignition timing as described in Ignition system — to time. Section E13 in this supplement. This should be 2° B.T.D.C.

Remove the contact breakers and clean the points. Fit the contact breakers and set the gaps to 0·014 in. to 0·016 in.

**Eleventh paragraph to read:—**

Fit the air silencer after first cleaning the filter element. The remaining information in this section is applicable to the S3 engine.